THE SOIL SCIENCE SOCIETY OF FLORIDA

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PROCEEDINGS
VOLUME III
1941

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Spring Meeting of the Society
Orlando
April 15, 1941

Third Annual Meeting of the Society
Gainesville
December 4-5, 1941

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OFFICERS OF THE SOCIETY
1941

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ACKNOWLEDGMENTS

It is the desire of the Executive Committee of the Society to express their sincere appreciation for the splendid cooperation of the Officials of the Florida State Horticultural Society in the development of the Spring Meeting in Orlando and to the Officials of the Orange Court Hotel for their courteous and efficient handling of the needs of the group through those sessions; also to the Officials of the University of Florida for the splendid space provided in the Florida Union and in the College of Agriculture for holding the Autumn Meetings.

Sustaining Memberships (1940-41)

In view of the growing financial responsibility of the Society, we are happy indeed to list the first Sustaining Memberships that have been taken by a number of individuals and corporations in various parts of the State. As provided by an action of the Executive Committee, elsewhere, this class of membership for the individual is ten dollars per annum and for the corporation or association, twenty-five dollars per annum.

American Potash Institute	Atlanta (Ga.)
U. S. Sugar Corporation	Clewiston
Chilean Nitrate Educational Bureau	Orlando
Fellsmere Sugar Producers Association	Fellsmere
Florida Power and Light Company	Miami
Miami Jockey Club	Hialeah
Organic Nitrogen Institute	Richmond (Va.)
Mr. C. J. Gonterman	Clewiston
Mr. Lindsay Stead	Ft. Pierce

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HARRY LEACH (1891-1941)
An Early Picture
(About 1925)

DEDICATION

Harry Raymond Leach
1891-1941

Harry Raymond Leach was born in Saginaw, Michigan, in 1891 and graduated from the University of Michigan at Ann Arbor, with a degree in Civil Engineering, in 1916. For a short time thereafter he was associated with Mr. Robert E. Horton, nationally known hydraulic engineer of Vorheesville, New York.

Harry R. Leach, June, 1939, on the old spillway of the lower lock of the St. Lucie Canal near Stuart, Fla.

Following his experience in the Signal Corps of the U. S. Army in the First World War, Mr. Leach had several engineering connections including water resources studies in Utah, flood studies in the Saginaw area, Michigan, and irrigation work with the Indian Service in the Southwest. By 1921, however, he was again employed by Mr. Horton and continued in this association until 1934. In 1935 he became affiliated with the Soil Conservation Service of the U. S. Department of Agriculture as Hydraulic Engineer and served this organization until his untimely death in 1941.

During the period of his association with the Soil Conservation Service Mr. Leach was given a highly important, though not a full time assignment, in connection with the development of a soil and water conservation program in the Florida Everglades for which the organization received its first funds from the National Congress in 1940.

It will be given to few men to develop such a thorough appreciation and understanding of the broad significance of the soil and water relationships existing in the Everglades area in the manner that Harry Leach did in the comparatively few months that he was allowed to work on that great project. In view of the fact that his contact with the Ever-

glades study that is now under way was through the period of its early inception, his contribution to the work was very real and will stand for a long time to come.

However, it is not alone as an expression of appreciation for the fine help he gave in connection with the hydraulic and hydrologic phases of our Everglades problems that we are privileged to dedicate this volume to Harry Raymond Leach. It is also our admiration for those qualities in the man which made him admired and respected by all who knew him and worked with him and the sterling interest and unlimited zeal he always had for the things he was doing to the end that right up to the close of a desperate illness for which there was no possible cure there was no thought, whatsoever, in his mind, according to his wife, but that one day he would be working with us again in Florida on soil and water conservation problems that were so close to his heart. It was with this thought firmly in mind that he passed into the Great Beyond. After all, there is little question that he is still working with us, for the influence of men like Leach does not soon die, if ever.—R. V. ALLISON

SPECIAL MEETING
FERTILIZER RECOMMENDATIONS COMMITTEE

MR. W. L. TAIT, *Chairman*
Orlando, Florida, Orange Court Hotel
April 15, 1941, 10:00 A.M.

A special session of the Fertilizer Recommendations Committee of the Society was called by the Chairman to appoint sub-committees for special crops or groups of crops and to discuss, generally, plans for the future centering around FORMS that had been developed prior to the meeting. These forms were prepared as a basis for the collection and analysis of data and in this way to assist somewhat in simplifying a field that otherwise is likely to appear quite complicated.

The meeting was called to order at 10:00 A. M. with the following members present at the time or during the course of the discussion that followed: W. L. Tait, J. F. Bazemore, G. H. Blackmon, R. A. Carrigan, Dana G. Coe, R. S. Edsall, W. T. Forsee, Jr., J. R. Henderson, F. S. Jamison, J. R. Neller, F. M. O'Byrne, W. H. Sachs, F. B. Smith, H. A. Thullbery, and R. V. Allison.

First attention was given by the Chairman to what might be regarded as the "job description" of the Committee in which it was pointed out that the primary responsibility of the group is a tabulation and analysis of existing data in the field of Soil Fertility as a basis for understanding its deficiencies and for such assistance as it will afford in outlining plans for research and study in the future which will best help in supplying these deficiences. (See pp. 65-66, Proceedings Vol. I, 1939, for the original personnel of the Committee and the earlier description of this field of activity.)

THE IMPORTANCE OF THE SOIL SURVEY

Naturally, one of the first questions taken up was the present status of the soil survey in the State. All present acknowledged the very great importance of describing and mapping our soil types as a basis for organizing systematic studies of soil and plant relationships in the field of soil fertility. This point was not only discussed at considerable length but the backward condition of Florida's soil survey program was emphasized and, in fact, deplored. Dr. F. B. Smith particularly stressed the need for the survey from the educational standpoint.

In discussing our soil fertility problems from this general viewpoint Mr. J. R. Henderson first presented "A Practical Grouping of Florida Soils," the details of which are shown in Table 1, where they require no explanation. The principal idea in such an arrangement of the soils of the State is to go from the familiar and commonly known group names such as "High Pine Land," etc., on through easily recognizable profile characteristics, such as "clay subsoil," "marl subsoil," etc., to the listing of the various soil types, as we now know them, that naturally fall into each of the general groups.

TABLE 1.—A PRACTICAL GROUPING FOR FLORIDA SOILS *

I. *High Pine Land*

1. Clay subsoil
   - a. Norfolk, Ruston and Orangeburg fine sandy loams and loamy fine sands and Marlboro, Tifton, Faceville, Carnegie and Magnolia fine sandy loams.
   - b. Esto, Bowie, Cuthbert, Luverne, Sawyer, Boswell and Susquehanna fine sandy loams.
   - c. Dunbar fine sandy loam.
   - d. Archer fine sandy loam and fine sand.
   - e. Rex fine sandy loam and loamy fine sand.
   - f. Eulonia and Fairhope fine sandy loams.
2. Sandy subsoil
   - a. Norfolk, Eustis, Ruston and Blanton fine sands.
   - b. Orlando and Ft. Meade fine sands.
3. Limerock substratum with or without clay subsoil
   Hernando fine sandy loam and Hernando and Newberry fine sands.

II. *Flat Pine Land*

4. Clay subsoil
   Bladen, Coxville, Scranton, Portsmouth and Plummer fine sandy loams; Bladen loamy fine sand and Sunniland loamy fine sand.
5. Sandy subsoil
   Portsmouth, Scranton and Plummer fine sands and loamy fine sands.
6. Hardpan subsoil
   Leon, Immokalee and St. Johns fine sands.
7. Marl or limestone substratum
   Bradenton fine sandy loam and loamy fine sand; Broward fine sandy loam and fine sand and Keri fine sand.

III. *High Hammock Land*

8. Clay subsoil
   - a. Norfolk, Ruston, Orangeburg, Red Bay, Marlboro, Faceville, Magnolia, Greenville, Blakely, Tifton, Carnegie, Shubuta fine sandy loams; and Norfolk, Ruston, Orangeburg and Red Bay loamy fine sands. Greenville fine sandy clay loam and Blakely loam.
   - b. Cuthbert, Luverne, Boswell, Susquehanna and Shubuta fine sandy loams.
   - c. Arredondo and Gainesville loamy fine sands and fine sandy loams and Fellowship fine sandy loam and clay loam.
9. Sandy subsoil
   - a. Norfolk, Ruston, Blanton and Eustis fine sands.
   - b. Orlando and Ft. Meade fine sands.

IV. *Low Hammock Land*

10. Clay subsoil
    Bladen and Coxville fine sandy loams and Bladen loamy fine sand.
11. Sandy subsoil
    Portsmouth fine sand
12. Marl or limestone substratum
    Parkwood, Manatee, Bradenton and Matmon fine sandy loams and Matmon and Manatee clay loams.

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* Of the "sandy" soil types only the fine sandy loams, loamy fine sands and fine sands are listed in most of the soil series. Sandy loams, loamy sands and sands are unimportant except in the case of the Norfolk series which includes fairly large areas of sand.

V. *Redlands Pine Land*

13. Rockland

Rockdale soils.

VI. *Prairie Land*

14. Clay subsoil

Bayboro, Bladen and Hyde fine sandy loams.

15. Sandy subsoil

Portsmouth, Plummer, Arzell and Charlotte fine sands.

16. Hardpan subsoil

Leon and Immokalee fine sands.

17. Marl

Perrine, Tucker and Ochopee marls and Ochopee marly fine sand.

VII. *Marsh Lands*

18. Peat and peaty muck

a. Everglades peat and Okeelanta peaty muck (slightly acid).
b. Other peats (strongly acid).

19. Muck

a. Okeechobee muck.
b. Pamlico muck.

VIII. *Blackjack Land*

20. Blackjack land

Norfolk sand and fine sand, deep phases.

IX. *Scrub Land*

21. Scrub land—dry

Lakewood, St. Lucie and Dade fine sands and Norfolk sand and fine sand, scrub phases.

22. Scrub land—wet

Arzell and Charlotte fine sands.

X. *Swamp Land*

23. Grady pond land

Grady clay loam and fine sandy loam.

24. Miscellaneous swamp lands.

XI. *Bottom Lands*

25. Second bottoms and terraces—clay subsoil

a. Amite, Chattahoochee, Flint, Cahaba and Kalmia fine sandy loams.
b. Leaf and Izzagora fine sandy loams.
c. Myatt fine sandy loam and Okenee loam.

26. Second bottoms and terraces—sandy subsoil

Cahaba and Kalmia fine sands.

27. First bottoms—clay subsoil

a. Congaree and Ochlockonee fine sandy loams and Congaree silt loam.
b. Iuka and Thompson fine sandy loams.
c. Chewacla and Wehadkee fine sandy loams and silt loams.
d. Johnston and Bibb fine sandy loams.

28. First bottoms—sandy subsoil

a. Thompson fine sand.
b. Johnston and Bibb fine sands.

IMPORTANT CROP GROUPS

By way of putting Table 1 to work, as it were, two additional tables of information were presented by Mr. Henderson. The first, Table 2, includes a listing of field, vegetable, fruit and nut crops arranged (A)

TABLE 2.—RELATIVE IMPORTANCE OF CROPS PRODUCED IN FLORIDA.
A. According to Acerage or Number of Trees
B. According to Value of Products

Field Crops

1936-37[1] B	1936-37[1] A	Crop	1939-40[2] A	1939-40[2] B
2	1	Corn	1	1
1	2	Peanuts	2	4
5	3	Upland Cotton	5	5
7	4	Velvet Beans	3	7
8	5	Hay & Forage	4	8
4	6	Sugar Cane for Sugar	7	3
10	7	Field Peas	6	10
3	8	Tobacco	8	2
6	9	Sugar Cane for Syrup	9	6
9	10	Sea Island Cotton	10	9
12	11	Oats	11	11
11	12	Chufas	—	—
15	13	Rye	—	—
16	14	Soy Beans	—	—
14	15	Rice	—	—
13	16	Sorghum for Syrup	—	—

Vegetable Crops

1936-37[1] B	1936-37[1] A	Crop	1939-40[2] A	1939-40[2] B
2	1	String Beans	1	2
1	2	Tomatoes	2	1
3	3	Irish Potatoes	3	4
7	4	Sweet Potatoes	5	10
11	5	Watermelons	4	9
9	6	Cabbage	6	7
6	7	Peppers	10	6
10	8	Lima Beans	12	13
8	9	English Peas	11	12
5	10	Strawberries	9	5
4	11	Celery	8	3
14	12	Squash	—	—
12	13	Cucumbers	7	8
13	14	Egg Plant	14	14
16	15	Okra	—	—
15	16	Lettuce	13	11
22	17	Cantaloupes	16	16
17	18	Escarole	15	15
20	19	Beets	—	—
19	20	Onions	—	—
29	21	Cassava	—	—
18	22	Endive	—	—
23	23	Carrots	—	—
26	24	Collards	—	—
25	25	Turnips	—	—
24	26	Romaine	—	—
21	27	Broccoli	—	—
28	28	Dasheens	—	—
27	29	Pineapples	16	15

Fruit and Nut Crops

1936-37[1] B	1936-37[1] A	Crop	1939-40[2] A	1939-40[2] B
1	1	Oranges	1	1
2	2	Grapefruit	2	2
3	3	Tangerines	3	3
11	4	Tung	4	—
6	5	Limes	5	5
5	6	Avocados	6	6
4	7	Pecans	7	4
14	8	Guavas	—	—
8	9	Mangoes	—	—
17	10	Bananas	—	—
9	11	Lemons	—	—
13	12	Papayas	—	—
10	13	Pears	—	8
12	14	Peaches	—	9
20	15	Coconuts	—	—
18	16	Japanese Persimmons	—	—
15	17	Figs	—	—
16	18	Plums	—	—
19	19	Blueberries	—	—
21	20	Sugar Apples	—	—
22	21	Sapodillas	—	—
7	*	Grapes	8	7

[1] Florida Department of Agriculture, Agricultural Statistical Report (1936-37).

* Grape acreage not given.

[2] Office Agricultural Marketing Service, Orlando. Notes by Mr. Marks (5-12-41) in comparing values with those of Department of Agriculture for 1936-37:

"FIELD CROPS—Under A you will note that the crops differ but little in relative ranking from your list. The cotton acreage has decreased and therefore drops down a little in the acreage scale. For the values, the main difference is that our Bureau for peanuts carries only peanuts harvested for nuts. If all peanuts were included, this could easily move up into first place ahead of corn. The few remaining crops are not carried by this office.

"VEGETABLE CROPS—Under vegetables a number of crops are carried which are not at the present time being estimated by this office. For the more important crops you will note that my rating for 1940 checks very closely with the figures which you have furnished. One crop, squash, is not shipped in solid cars and still is important enough so that it probably should be carried. Based on figures of truck crop movement, this should come in ahead of escarole which would make it about 14 in acreage and not far from this listing in value.

"FRUIT AND NUT CROPS—For the fruit and nut crops, I am giving the relative importance and value as far as I am able. There are a number of crops such as guavas, mangoes, bananas, etc. which we do not carry and therefore it is difficult to give pears and peaches their proper numbers in the acreage scale. It does seem that they should come in ahead of mangoes, bananas and papayas but I may be wrong about this."

TABLE 3.—Comparative Importance of Various Soil Groups in the Production of the Principal Field, Truck, and Tree Crops Grown in Florida.*

Soil Groups	Field Crops **										Truck Crops															Bulbs		Tree Crops: Citrus					Tree Crops: Other				Misc.	
Abbreviations: fsl—fine sandy loam; sl—sandy loam; lfs—loamy fine sand; ls—loamy sand; fs—fine sand; s—sand; l—loam; and, cl—clay loam	Corn with peanuts and velvet beans	Corn alone	Peanuts alone	Cotton, upland	Cotton, Sea Is.	Cowpeas, v. beans	Oats, rye	Sugar cane	Tobacco, bright	Tobacco, shade	Beans, lima Peas, English	Beans, string	Cabbage	Celery	Cucumbers	Egg plant	Endive, Escarole	Lettuce	Pepper	Potatoes, Irish	Potatoes, sweet	Squash	Strawberries	Tomatoes	Watermelons	Gladiolus	Narcissus	Oranges	Grapefruit	Tangerines	Lemons	Limes	Avocados	Mangoes	Pecans	Tung	Grapes	Papayas
Blakely fsl, sl and l (8-a) Greenville fsl, sl, fscl and scl Red Bay fsl and sl	1	1	1	1	—	1	1	1	—	1	—	3	3	—	—	—	—	—	—	—	1	—	—	—	2	—	2	—	—	—	—	—	—	—	1	1	—	—
Red Bay lfs and ls (1-a & 8-a) Orangeburg fsl, sl, lfs and ls	1	1	1	1	—	1	1	1	3	1	—	3	3	—	—	—	—	—	—	—	1	—	—	—	2	—	2	—	—	—	—	—	—	—	1	1	—	—
Magnolia fsl and sl (1-a & 8-a) Faceville fsl and sl Carnegie fsl and sl	1	1	1	1	—	1	1	1	—	1	—	3	3	—	—	—	—	—	—	—	1	—	—	—	2	—	2	—	—	—	—	—	—	—	1	3	—	—
Tifton fsl and sl (1-a & 8-a) Marlboro fsl and sl	1	1	1	1	—	1	1	1	3	1	—	3	3	—	—	—	—	—	—	2	1	—	—	—	1	—	2	—	—	—	—	—	—	—	1	3	—	—
Ruston fsl, sl, lfs and ls (1-a & 8-a) Norfolk fsl, sl, lfs and ls	1	1	1	1	—	1	1	1	2	1	—	3	3	—	—	—	—	—	—	2	1	—	—	—	1	—	2	—	—	—	—	—	—	—	1	2	—	—
Bowie fsl and sl (1-b & 8-b) Cuthbert fsl and sl Luverne fsl and sl	3	3	3	3	—	3	3	3	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	3	—	—	—	—	—	—	—	—	—	3	—	—	—
Sawyer fsl and sl (1-b & 8-b) Boswell fsl and sl Shubuta fsl and sl Susquehanna fsl and sl	3	3	3	3	—	3	3	3	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	3	—	—	—	—	—	—	—	—	—	3	—	—	—

Esto fsl and sl (1-b & 8-b) Hoffman fsl and sl	3	3	3	3	—	3	3	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	3	—	—	—
Ruston fs and s (2-a & 9-a)	2	2	2	2	2	2	3	3	3	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	2	—	—	—	—	—	—	—	—	—	2	—	—	—
Eustis fs and s (2-a & 9-a) Norfolk fs and s (Also 20)	1	1	1	1	1	1	1	1	1	—	—	—	—	—	1	2	—	—	3	—	1	—	—	—	1	—	—	1	1	1	1	1	3	1	1	1	1	—
Blanton fs and s (2-a & 9-a)	2	2	2	3	2	2	2	2	1	—	—	—	—	—	1	2	—	—	3	—	1	—	—	—	1	—	—	1	1	1	3	3	3	2	2	1	1	—
Orlando fs and s (2-b & 9-b) Ft. Meade fs and s	2	2	2	—	2	2	3	2	2	—	2	3	2	—	1	1	—	—	2	—	1	1	1	1	2	—	—	1	1	1	3	3	3	2	2	1	—	—
Norfolk fs and s, scrub phases (21) Lakewood fs and s St. Lucie fs and s	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	3	3	3	3	3	3	—	—	—	—
Arredondo fsl, sl, lfs and ls (8-c) Gainesville fsl, sl, lfs and ls	1	1	1	3	1	1	1	2	1	—	3	3	3	—	3	2	—	—	2	—	1	3	—	—	2	—	—	2	2	2	—	—	—	—	2	1	—	—
Fellowship fsl, sl and cl (8-c)	3	3	3	3	3	2	2	3	3	—	2	3	2	—	2	2	—	2	2	—	2	2	—	—	—	—	—	3	3	3	—	—	—	—	—	3	—	—
Hernando fsl, sl, lfs and ls (3) Archer fsl, sl, lfs and ls (1-d)	1	1	1	3	1	1	1	2	1	—	—	—	—	—	1	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	1	2	—	—
Newberry fs and s (3)	2	2	1	—	1	2	2	2	1	—	—	—	—	—	1	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	2	3	—	—
Dade fs and s (21)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	2	2	2	2	2	2	—	—	—	2
Palm Beach fs and s	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rockdale soils (13)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	1	1	1	1	1	1	1	—	—	—	1
Dunbar fsl, sl, lfs and ls (1-c)	2	2	3	3	—	2	2	1	—	—	—	—	—	—	—	—	—	—	—	2	1	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—
Eulonia fsl, sl, lfs and ls (1-f) Fairhope fsl, sl, lfs and ls	3	3	3	—	—	3	3	3	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—
Blanton lfs and ls (1-e) Rex fsl, sl, lfs and ls	3	3	3	—	3	3	3	3	2	—	1	2	3	—	2	2	—	—	2	—	2	3	—	—	—	—	—	3	3	3	—	—	—	—	1	3	—	—
Bladen fsl, sl, lfs and ls (10 & 14) Coxville fsl, sl, lfs and ls	—	2	—	—	—	2	2	3	—	—	2	2	1	2	2	1	1	1	1	1	1	2	2	1	—	1	1	1	1	1	2	3	—	1	1	—	—	—
Portsmouth fsl, sl, lfs and ls (4, 5, Scranton fsl, sl, lfs and ls & 11)	—	2	—	—	—	2	3	3	—	—	1	1	1	2	1	1	2	2	1	1	1	1	1	1	—	1	1	2	2	2	2	3	3	2	2	—	—	1
Plummer fsl, sl, lfs and ls (4)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Bayboro fsl, sl and cl (14) Hyde fsl, sl and l	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

TABLE 3.—COMPARATIVE IMPORTANCE OF VARIOUS SOIL GROUPS IN THE PRODUCTION OF THE PRINCIPAL FIELD, TRUCK, AND TREE CROPS GROWN IN FLORIDA.*—(Concluded)

Soil Groups	Field Crops **										Truck Crops															Bulbs		Tree Crops									Misc.	
																												Citrus					Other					
Abbreviations: fsl—fine sandy loam; sl—sandy loam; lfs—loamy fine sand; ls—loamy sand; fs—fine sand; s—sand; l—loam; and, cl—clay loam	Corn with peanuts and velvet beans	Corn alone	Peanuts alone	Cotton, upland	Cotton, Sea Is.	Cowpeas, v beans	Oats, rye	Sugar cane	Tobacco, bright	Tobacco, shade	Beans, lima Peas, English	Beans, string	Cabbage	Celery	Cucumbers	Egg plant	Endive, Escarole	Lettuce	Pepper	Potatoes, Irish	Potatoes, sweet	Squash	Strawberries	Tomatoes	Watermelons	Gladiolus	Narcissus	Oranges	Grapefruit	Tangerines	Lemons	Limes	Avocados	Mangoes	Pecans	Tung	Grapes	Papayas
Grady fsl, sl, and cl (23)	—	3	—	—	—	—	3	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Portsmouth fs and s (5 & 11) Plummer fs and s	—	2	—	—	—	2	3	3	—	—	2	1	1	1	1	1	1	1	1	1	1	1	1	1	—	1	1	2	2	2	3	3	3	2	—	—	—	1
Charlotte fs and s (15 & 22) Arzell fs and s	—	3	—	—	—	—	—	—	—	—	1	1	2	—	—	2	—	—	1	2	—	1	—	1	—	1	1	—	—	—	—	—	3	—	—	—	—	1
Sunniland lfs (4)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	2	—	—	3	—	—	1	—	2	—	2	2	3	3	3	3	3	3	2	—	—	—	2
Leon fs and s (6 & 16) Immokalee fs and s St. Johns fs and s	—	3	—	—	—	—	—	—	—	—	3	3	2	1	3	3	1	2	3	3	—	—	—	3	—	2	2	3	3	3	—	3	3	2	—	—	—	2
Parkwood fsl and sl (12) Matmon fsl and sl	—	3	—	—	—	—	—	—	—	—	—	3	1	—	—	—	—	—	3	—	—	—	—	—	—	—	—	1	1	1	3	3	—	1	—	—	—	1
Manatee fsl, sl and cl (12)	—	3	—	—	—	—	—	—	—	—	—	3	1	1	—	—	—	1	2	3	—	2	—	1	—	2	2	2	2	2	—	—	—	—	—	—	—	2
Bradenton fsl, sl, lfs and ls (7) Broward lfs, ls, fs and s	—	3	—	—	—	—	—	—	—	—	3	2	1	2	2	1	—	2	1	2	—	1	2	1	—	1	1	1	1	1	3	3	—	1	—	—	—	1
Keri fs and s (7) Ochopee marly fs and marly s	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	3
Perrine marl (17) Tucker marl Ochopee marl	—	3	—	—	—	—	—	—	—	—	3	2	2	—	3	3	—	2	2	1	—	1	3	1	—	—	—	3	3	3	—	—	—	—	—	—	—	1

Everglades peat	(18-a)	—	3	—	—	—	—	—	2	—	—	1	1	1	1	—	3	1	3	1	1	—	1	—	1	—	3	3	2	2	2	—	—	—	—	—	—	—	2
Okeelanta peaty muck	(18-a)	—	3	—	3	—	—	—	1	—	—	1	1	1	1	—	3	1	3	1	1	—	1	—	1	—	1	1	2	2	2	—	—	—	—	—	—	—	2
Okeechobee muck	(19-a)	—	3	—	3	—	—	—	1	—	—	1	1	1	1	—	3	1	3	1	1	—	1	—	1	—	1	1	3	3	3	—	—	—	—	—	—	—	2
Acid saw-grass and cat-tail peat	18b	—	3	—	3	—	—	—	—	—	—	—	—	3	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Acid woody peat	(18-b)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pamlico muck	(19-b)	—	3	—	—	—	—	—	—	—	—	—	2	2	1	—	—	1	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Amite fsl and sl	(25-a)	3	3	3	3	—	3	3	3	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Chattahoochee fsl and sl Flint fsl and sl	(25-a)	3	3	3	3	—	3	3	3	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cahaba fsl, sl, lfs and ls Kalmia fsl, sl, lfs and ls	(25-a)	3	3	3	3	—	3	3	3	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cahaba fs and s Kalmia fs and s	(26)	3	3	3	3	—	3	3	3	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Leaf fsl, sl and cl Izzagora fsl and sl	(25-b)	3	3	3	3	—	3	3	3	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Myatt fsl, sl, lfs and ls	(25-c)	3	3	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Okenee fsl, sl and l	(25-c)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Congaree fsl, sl and silt l	(27-a)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ochlockonee fsl and sl	(27-a)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Thompson fsl, sl, lfs and ls	(27-b)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Thompson fs and s	(28-a)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Chewacla fsl, sl and silt l Wehadkee fsl, sl and silt l	(27-c)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Iuka fsl and sl	(27-b)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Johnston fsl, sl, lfs and ls Bibb fsl, sl, lfs and ls	(27-d)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Johnston fs and s Bibb fs and s	(28-b)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

* 1, major importance; 2, medium importance; 3, minor importance; and, —, no importance or not grown.

** Range and improved pasture included in crop listing of Form I.

FORM I.—Field Crops.

Soil Types [1]	Soil Group [2]	Virgin Soil	Corn with peanuts and velvet beans	Corn alone	Peanuts alone	Cotton, upland	Cotton, Sea Island	Cowpeas, Velvet beans	Oats, Rye	Sugar Cane	Tobacco, bright	Tobacco, shade	Cultivated pasture	Range pasture			Remarks
Blakely fsl, sl, and 1 Greenville fsl, sl, fscl and scl Red Bay fsl and sl	(8-a)		*	*	*	*		*	*	*		*					
Magnolia fsl and sl Orangeburg fsl, sl, lfs and ls	(1-a & 8-a)		*	*	*	*		*	*	*		*					
Magnolia fsl and sl Faceville fsl and sl Carnegie fsl and sl	(1-a & 8-a)		*	*	*	*		*	*	*		*					
Tifton fsl and sl Marlboro fsl and sl	(1-a & 8-a)		*	*	*	*		*	*	*		*					
Ruston fsl, sl, lfs and ls Norfolk fsl, sl, lfs and ls	(1-a & 8-a)		*	*	*	*		*	*	*	*	*					
Ruston fs and s	(2-a & 9-a)		*	*	*	*	*	*									
Eustis fs and s Norfolk fs and s	(2-a & 9-a) (Also 20)		*	*	*	*	*	*	*	*	*						
Blanton fs and s	(2-a & 9-a)		*	*	*		*	*	*	*	*						
Orlando fs and s Ft. Meade fs and s	(2-b & 9-b)		*	*	*		*	*		*	*						
Arredondo fsl, sl, lfs and ls Gainesville fsl, sl, lfs and ls	(8-c)		*	*	*		*	*	*	*	*						

Fellowship fsl, sl and cl	(8-c)							*	*								
Hernando fsl, sl, lfs, and ls Archer fsl, sl, lfs and ls	(3) (1-d)		*	*	*		*	*	*	*	*						
Newberry fs and s	(3)		*	*	*		*	*	*	*	*						
Dunbar fsl, sl, lfs and ls	(1-c)		*	*				*	*	*							
Bladen fsl, sl, lfs and ls Coxville fsl, sl, lfs and ls	(10 & 14)			*				*	*								
Portsmouth fsl, sl, lfs and ls Scranton fsl, sl, lfs and ls	(4, 5 & 11)			*				*									
Plummer fsl, sl, lfs and ls	(4)												*	*			
Bayboro fsl, sl and cl Hyde fsl, sl and l	(14)												*	*			
Portsmouth fs and s Plummer fs and s	(5 & 11)			*				*					*	*			
Leon fs and s Immokalee fs and s St. Johns fs and s	(6 & 16)												*	*			
Everglades peat	(18-a)									*			*				
Okeelanta peaty muck	(18-a)									*			*				
Okeechobee muck	(19-a)									*							
Blanton lfs and ls Rex fsl, sl, lfs and ls											*						

[1] For abbreviations see table 3, p. 12.

[2] Refers to soil groupings, in Table 1, p. 9.

* Cropping relationships "2" or better as listed Table 3, p. 12.

Form II.—Truck Crops.

Soil Types[1]	Soil Group[2]	Virgin Soil	Beans, Lima	Peas, English	Beans, String	Cabbage	Celery	Cucumbers	Egg Plant	Endive and Escarole	Lettuce	Pepper	Potatoes, Irish	Potatoes, Sweet	Squash	Strawberries	Tomatoes	Watermelons			Remarks
Blakely fsl, sl and l Greenville fsl, sl, fscl and scl Red Bay fsl and sl	(8-a)													*				*			
Red Bay lfs and ls Orangeburg fsl, sl, lfs and ls	(1-a & 8-a)													*				*			
Magnolia fsl and sl Faceville fsl and sl Carnegie fsl and sl	(1-a & 8-a)													*				*			
Tifton fsl and sl Marlboro fsl and sl	(1-a & 8-a)												*	*				*			
Ruston fsl, sl, lfs and ls Norfolk fsl, sl, lfs and ls	(1-a & 8-a)												*	*				*			
Ruston fs and s	(2-a & 9-a)													*				*			
Eustis fs and s Norfolk fs and s	(2-a & 9-a) (20)							*	*					*				*			
Blanton fs and s	(2-a & 9-a)							*	*					*				*			
Orlando fs and s Ft. Meade fs and s	(2-b & 9-b)		*	*		*		*	*			*		*	*	*	*	*			
Arredondo fsl, sl, lfs and ls Gainesville fsl, sl, lfs and ls	(8-c)								*			*		*				*			

Fellowship fsl, sl and cl	(8-c)		*	*		*		*	*		*	*		*	*						
Hernando fsl, sl, lfs and ls Archer fsl, sl, lfs and ls	(3) (1-d)							*						*				*			
Newberry fs and s	(3)							*						*				*			
Rockdale soils	(13)																*				
Dunbar fsl, sl, lfs and ls	(1-c)												*	*							
Eulonia fsl, sl, lfs and ls Fairhope fsl, sl, lfs and ls	(1-f)													*							
Blanton lfs and ls Rex fsl, sl, lfs and ls	(1-e)		*	*	*			*	*			*		*							
Bladen fsl, sl, lfs and ls Coxville fsl, sl, lfs and ls	(10 & 14)		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
Portsmouth fsl, sl, lfs and ls Scranton fsl, sl, lfs and ls	(4, 5, & 11)		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
Portsmouth fs and s Plummer fs and s	(5 & 11)		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
Charlotte fs and s Arzell fs and s	(15 & 22)		*	*	*	*			*			*	*		*		*				
Sunniland lfs	(4)								*						*		*				
Leon fs and s Immokalee fs and s St. Johns fs and s	(6 & 16)					*	*			*	*										
Parkwood fsl and sl Matmon fsl and sl	(12)					*															
Bradenton fsl, sl, lfs and ls Broward lfs, ls, fs and s	(7)				*	*	*	*	*		*	*	*		*	*	*				

FORM II.—TRUCK CROPS—(Concluded).

Soil Types [1]	Soil Group [2]	Virgin Soil	Beans, Lima	Peas, English	Beans, String	Cabbage	Celery	Cucumbers	Egg Plant	Endive and Escarole	Lettuce	Pepper	Potatoes, Irish	Potatoes, Sweet	Squash	Strawberries	Tomatoes	Watermelons			Remarks
Keri fs and s Ochopee marly fs and marly s	(7) (17)																*				
Perrine Marl Tucker Marl Ochopee Marl	(17)				*	*					*	*	*		*		*				
Everglades peat	(18-a)		*	*	*	*	*			*		*	*		*		*				
Okeelanta peaty muck	(18-a)		*	*	*	*	*			*		*	*		*		*				
Okeechobee muck	(19-a)		*	*	*	*	*			*		*	*		*		*				
Acid sawgrass and cat-tail peat	(18-b)						*														
Pamlico muck	(19-b)				*	*	*			*	*	*									
Manatee fsl, sl, and cl	(12)					*	*				*	*			*		*				

[1] For abbreviations see Table 3, p. 12.
[2] Refers to soil groupings, in Table 1, p. 9.
* Cropping relationships "2" or better as listed Table 3, p. 12.

in the order of acreage or number of trees and (B) according to the approximate annual value of the products. These values for the year 1936-37 were obtained from the statistical report of the State Department of Agriculture while those for 1939-40 were kindly supplied by Mr. H. A. Marks, Agricultural Statistician of the Agricultural Marketing Service, U. S. Department of Agriculture, Orlando.

SOILS UPON WHICH THE MORE IMPORTANT CROPS ARE GROWN

Having the soil types outlined in a general way, Table 1, and the principal crops listed, Table 2, it is only natural that effort should be made to bring them together on the basis of the importance of the culture of these crops on the various soils. This has been undertaken in a tentative way in Table 3 in which the following categories of importance for these cropping relationships are indicated as: (1) Major importance; (2) medium importance; (3) minor importance; and (—) no importance or not grown. In the first column of Table 3 the reader is referred back to Table 1 by the numerals on the right in the event he may care to ascertain to what general soil group any particular type or types belongs.

STUDY FORMS

In order to reduce such a complex table as No. 3 to a working basis and at the same time provide helpful outlines for the use of the various sub-committees of the general committee, four tentative forms were prepared from that table covering the following categories of crops: I Field Crops, II Truck Crops, III Citrus, and IV Miscellaneous Horticultural Crops.

In these forms, as taken largely from Table 3, those soil and crop combinations are starred only that were indicated as of (1) Major importance or (2) Medium importance. This is for the purpose of bringing the number of combination for the study of some particular problem, such as pH or lime requirements, to as reasonable a number as possible. They are presented as a working plan and for improvement with use rather than as a finished product. This is well indicated by a few discrepancies in listings of soils between Tables I and III that may be noted.

The possible value of these forms from this standpoint was emphasized by Chairman Tait who briefly reviewed some rather extensive studies he has made in the past on soil reaction trends under citrus grove conditions. Mr. R. A. Carrigan contributed to this phase of the discussion by giving the high points of current studies in this same field that were planned at the Tampa meeting in April 1940 (Proc. Vol. 2, pp. 9-39). These studies were more fully reviewed in the course of the general meeting of the Society during the afternoon of this same date, Proceedings page 29.

In setting up Form III, information supplied by one of the committee members, Mr. R. E. Norris, of Tavares, who, unfortunately, was unable to attend the meeting, showing the relative importance of citrus stock and varieties in their association with soil types, was used instead of the treatment included in the other forms. In doing this the same meaning is attached to the numbers as was used in Table 3. This covers the

FORM III.—CITRUS.

Variety and Stock — Orange [3]

Soil Types [1]	Soil Group [2]	Hamlin: R. Lemon	Hamlin: So. Orange	Hamlin: Sw. Orange	Hamlin: Cl. Mandarin	Parson Brown: R. Lemon	Parson Brown: So. Orange	Parson Brown: Sw. Orange	Pineapple: R. Lemon	Pineapple: So. Orange	Pineapple: Sw. Orange	Pineapple: Grapefruit	Seedling: Sw. Irabage	Valencia and Lue Gim Gong: R. Lemon	Valencia and Lue Gim Gong: So. Orange	Valencia and Lue Gim Gong: Sw. Orange	Valencia and Lue Gim Gong: Grapefruit
Eustis fs and s	(2-a & 9-a)	1	1	2	3	1	1	2	1	1	2	3	1	1	1	2	3
Norfolk fs and s	(20)	1	2	2	2	1	2	2	1	1	1	3	1	1	2	2	3
Blanton fs and s	(2-a & 9-a)	1	2	2	2	1	2	2	1	1	1	3	1	1	2	2	3
Orlando fs and s	(2-b & 9-b)	1	2	2	2	1	2	2	1	1	1	3	1	1	2	2	3
Ft. Meade fs and s																	
Arredondo fsl, sl, lfs and ls	(8-c)																
Gainesville fsl, sl, lfs and ls																	
Dade fs and s	(21)																
Rockdale soils	(13)																
Bladen fsl, sl, lfs and ls	(10 & 14)																
Coxville fsl, sl, lfs and ls																	
Portsmouth fsl, sl, lfs and ls	(4, 5, & 11)																
Scranton fsl, sl, lfs and ls																	

Variety and Stock — Grapefruit [3] and Mandarin [3]

Soil Types [1]	Soil Group [2]	Seeded: R. Lemon	Seeded: So. Orange	Seeded: Sw. Orange	Seeded: Grapefruit	Seedless: R. Lemon	Seedless: So. Orange	Seedless: Sw. Orange	Seedless: Grapefruit	Dancy Tangerines: R. Lemon	Dancy Tangerines: So. Orange	Dancy Tangerines: Sw. Orange	Dancy Tangerines: Cl. Mandarin	Dancy Tangerines: Grapefruit
Eustis fs and s	(2-a & 9-a)	1	3	—	3	1	3	—	3	1	3	—	—	—
Norfolk fs and s	(20)	1	3	—	3	1	3	—	3	1	3	—	—	—
Blanton fs and s	(2-a & 9-a)	1	3	—	3	1	3	—	3	1	3	—	—	—
Orlando fs and s	(2-b & 9-b)	1	3	—	3	1	3	—	3	1	3	—	—	—
Ft. Meade fs and s														
Arredondo fsl, sl, lfs and ls	(8-c)													
Gainesville fsl, sl, lfs and ls														
Dade fs and s	(21)													
Rockdale soils	(13)													
Bladen fsl, sl, lfs and ls	(10 & 14)													
Coxville fsl, sl, lfs and ls														
Portsmouth fsl, sl, lfs and ls	(4, 5, & 11)													
Scranton fsl, sl, lfs and ls														

Variety and Stock — Hybrids [3], Lemon [3], Lime, Kumquat

Soil Types [1]	Soil Group [2]	Temple: R. Lemon	Temple: So. Orange	Temple: Cl. Mandarin	Tangelo: R. Lemon	Tangelo: So. Orange	Lemon, All Varieties: R. Lemon	Lemon, All Varieties: So. Orange	Lime, Tahiti: R. Lemon	Lime, Tahiti: So. Orange	Lime, Tahiti: Grapefruit	Kumquat, All Varieties: R. Lemon	Kumquat, All Varieties: So. Orange	Kumquat, All Varieties: Sw. Orange
Eustis fs and s	(2-a & 9-a)	3	2	1	2	1	1	3						
Norfolk fs and s	(20)	3	2	1	2	1	1	3						
Blanton fs and s	(2-a & 9-a)	3	2	1	2	1	1	3						
Orlando fs and s	(2-b & 9-b)	3	2	1	2	1	1	3						
Ft. Meade fs and s														
Arredondo fsl, sl, lfs and ls	(8-c)													
Gainesville fsl, sl, lfs and ls														
Dade fs and s	(21)													
Rockdale soils	(13)													
Bladen fsl, sl, lfs and ls	(10 & 14)													
Coxville fsl, sl, lfs and ls														
Portsmouth fsl, sl, lfs and ls	(4, 5, & 11)													
Scranton fsl, sl, lfs and ls														

FORM III.—Citrus—(Concluded).

Soil Types[1]	Soil Group[2]	Variety and Stock																																							
		Orange[3]																Grapefruit[3]								Mandarin[3]					Hybrids[3]					Lemon[3]		Lime			Kumquat		
		Hamlin				Parson Brown			Pineapple				Seedling	Valencia and Lue Gim Gong				Seeded				Seedless				Dancy Tangerine					Temple			Tangelo		All Varieties		Tahiti			All Varieties		
		R. Lemon	So. Orange	Sw. Orange	Cl. Mandarin	R. Lemon	So. Orange	Sw. Orange	R. Lemon	So. Orange	Sw. Orange	Grapefruit	Sw. Irabage	R. Lemon	So. Orange	Sw. Orange	Grapefruit	R. Lemon	So. Orange	Sw. Orange	Grapefruit	R. Lemon	So. Orange	Sw. Orange	Grapefruit	R. Lemon	So. Orange	Sw. Orange	Cl. Mandarin	Grapefruit	R. Lemon	So. Orange	Cl. Mandarin	R. Lemon	So. Orange	R. Lemon	So. Orange	R. Lemon	So. Orange	Grapefruit	R. Lemon	So. Orange	Sw. Orange
Portmouth fs and s Plummer fs and s	(5 & 11)	1	2	2	2	1	2	2	1	1	1	3	1	1	2	2	3	1	3	—	3	1	3	—	3	1	3	—	—	—	3	2	1	2	1	1	3						
Parkwood fsl and sl Matmon fsl and sl	(12)																																										
Manatee fsl, sl and cl	(12)																																										
Bradenton fsl, sl, lfs and ls Broward lfs, ls, fs and s	(7)																																										
Everglades peat	(18-a)																																										
Okeelanta peaty muck	(18-a)																																										

[1] For abbreviations, see Table 3, p. 12.

[2] Refers to soil groupings, in Table 1, p. 9.

[3] Numerals used in this form signify importance of variety and stock in relation to soil type, as used in Table 3, p. 12.

FORM IV.—Miscellaneous Horticultural Crops.

Soil Types [1]	Soil Group [2]	Virgin Soil	Avocados	Mangos	Pecans	Tung	Grapes	Papayas	Gladiolus	Narcissus								Remarks
Blakely fsl, sl and l Greenville fsl, sl, fscl and scl Red Bay fsl and sl	(8-a)				*	*				*								
Red Bay lfs and ls Orangeburg fsl, sl, lfs and ls	(1-a & 8-a)				*	*				*								
Magnolia fsl and sl Faceville fsl and sl Carnegie fsl and sl	(1-a & 8-a)				*					*								
Tifton fsl and sl Marlboro fsl and sl	(1-a & 8-a)				*					*								
Ruston fsl, sl, lfs and ls Norfolk fsl, sl, lfs and ls	(1-a & 8-a)				*	*				*								
Ruston fs and s	(2-a & 9-a)				*													
Eustis fs and s Norfolk fs and s	(2-a & 9-a) (20)			*	*	*	*											
Blanton fs and s	(2-a & 9-a)			*	*	*	*											
Orlando fs and s Ft. Meade fs and s	(2-b & 9-b)			*	*	*												
Arredondo fsl, sl, lfs and ls Gainesville fsl, sl, lfs and ls	(8-c)				*	*												
Hernando fsl, sl, lfs and ls Archer fsl, sl, lfs and ls	(3) (1-d)				*	*												
Newberry fs and s	(3)				*													
Dade fs and s	(21)		*	*				*										
Rockdale soils	(13)		*					*										

Dunbar fsl, sl, lfs and ls	(1-c)				*													
Blanton lfs and ls Rex fsl, sl, lfs and ls	(1-e)				*													
Bladen fsl, sl, lfs and ls Coxville fsl, sl, lfs and ls	(10 & 24)			*	*				*	*								
Portsmouth fsl, sl, lfs and ls Scranton fsl, sl, lfs and ls	(4, 5 & 11)			*	*			*	*	*								
Portsmouth fs and s Plummer fs and s	(5 & 11)			*				*	*	*								
Charlotte fs and s Arzell fs and s	(15 & 22)							*	*	*								
Sunniland lfs	(4)			*				*	*	*								
Leon fs and s Immokalee fs and s St. Johns fs and s	(6 & 16)			*				*	*	*								
Parkwood fsl and sl Matmon fsl and sl	(12)			*				*										
Manatee fsl, sl and cl	(12)							*	*	*								
Bradenton fsl, sl, lfs and ls Broward lfs, ls, fs and s	(7)			*				*	*	*								
Perrine Marl Tucker Marl Ochopee Marl	(17)							*										
Everglades Peat	(18-a)							*										
Okeelanta Peaty Muck	(18-a)							*	*	*								
Okeechobee Muck	(19-a)							*	*	*								

[1] For abbreviations, see Table 3, p. 12.

[2] Refers to soil groupings, in Table 1, p. 9.

* Cropping relationships "2" or better as listed Table 3, p. 12.

general area of Lake County only, whereas the information shown on the other forms is from a State-wide viewpoint. This information on Form III, being from a restricted area, is in greater detail, of course, and is useful in demonstrating the adaptability of such Forms to studies of this nature.

REDUCTION IN NUMBER OF AVAILABLE FERTILIZER GRADES

Following the presentation of the tables and forms a considerable amount of discussion was given to the importance of reducing the number of registered fertilizer grades and formulas in use in the State and the manner in which it might be accomplished. This was largely participated in by Dr. F. S. Jamison who not only emphasized the importance of reducing the number of grades and formulas registered but expressed himself as thoroughly sold on the survey methods of approach in the study of how this best can be done; and by Dr. Dana G. Coe [1] who emphasized his approval of the whole discussion by subsequently offering the appended list of grades as a "beginner" in the process of reduction from the many thousands that are now registered with the State Chemist in the Department of Agriculture each year.[2]

Mr. G. H. Blackmon expressed himself as strongly in favor of a reduction in the number of grades and emphasized the great responsibility of research in this connection. He also pointed out the advantages of simplification in this field for newcomers in the State since Florida doubtless has more fertilizer registrations than all other states combined; perhaps double or even treble that number!

The feasibility of placing a fee such as $3.00 or $5.00 on each new registration was discussed and favorably considered for the most part as a possible source of discouragement for hundreds of small tonnage formulas that are developed and registered each year.

In undertaking to formulate a plan for initiating the work of the committee on a rather broad scale, contacts with County Agricultural Agents, Vocational Agriculture Teachers and others, through the medium of the forms discussed, was generally approved and numerous suggestions were offered. Messrs. W. H. Sachs and J. F. Bazemore were favorably impressed with this approach from the fertilizer technologist's viewpoint, the latter expressing the opinion that work of this nature should have been started long ago.

The question of bringing in the trace element requirements of various

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[1] Shortly following the Annual meeting in Gainesville (Dec. 5 & 6) Dr. Coe submitted the following memorandum to the State Chemist and to certain members of the Fertilizer Recommendations Committee:

"Re: Grades of Mixed Fertilizers for Florida.

In view of the war emergency with the necessity of conserving materials, labor, equipment, plant space, power, transportation, and packages for fertilizers, it seems timely for Florida to follow other states in recommending ratios and grades of mixed fertilizers sold in the State. Research can fit the grades to each crop and soil later, if not now determined, but a start should be made now by recommending a list of fertilizer ratios and grades to the factories and farms for war economy. To start same, the following tentative list is submitted to the Soil Science Society of Florida for study and action. The minimum plant food is stepped up from 14 percent to 20 percent or more, except in the case of grade No. 1 below. The use of superphosphate and muriate of potash for said sources of P_2O_5 and K_2O is advised to avoid extra registrations. The adoption of 20 percent, 30 percent, and 40 percent organic nitro-

soil and plant associations at the proper time was raised by Dr. Coe and supported by a discussion from Mr. Edsall who emphasized the importance of foliar symptoms and of color photographs in recording studies of this nature.

As the time for closing the discussion drew near, Dr. J. R. Neller moved the appointment of appropriate sub-committees by the Chairman with the view of organizing smaller working groups having more localized interests. The motion was seconded by Mr. Thullbery who took the opportunity to express his amazement at the ramifications and extent of this field in Florida; also to note that the fertilizer needs of 3000 acres of grove handled by the organization of which he is head is largely served by 2 or 3 mixtures whereas as little as 500 acres of miscellaneous grove area, without benefit of cooperative management, might develop a need for 7 to 10 mixtures, a fact that clearly shows the advantages of a careful analysis and study of the problem.

The meeting adjourned promptly at 12:30 P. M. and the following Sub-Committees of the General Committee were subsequently appointed by the Chairman:

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gen mixtures is urged where a broad offering of grades of a given analysis is desired, otherwise the 30 percent organic nitrogen mixture should be standard.

No.	Ratio			Analysis chosen			Other analyses Displaced
	N	P_2O_5	K_2O	N	P_2O_5	K_2O	
1	16	0	0	16	0	0	Mixture of N sources
2	3	0	1	15	0	5	12-0-4, etc.
3	3	0	2	12	0	8	
4	1	0	1	10	0	10	12-0-12; 8-0-8; etc.
5	2	0	3	8	0	12	
6	0	3	1	0	15	5	0-12-4, etc.
7	0	1	1	0	10	10	0-12-12; 0-8-8; etc.
8	0	1	2	0	8	16	0-10-20; 0-7-14; etc.
9	0	1	3	0	8	24	0-5-15; 0-4-12; etc.
10	1	1	1	8	8	8	5-5-5; 7-7-7; etc.
11	1	2	1	6	12	6	4-8-4; etc.
12	1	3	1	4	12	4	3-9-3; etc.
13	1	3	2	4	12	8	3-9-6; etc.
14	1	2	3	4	8	12	
15	1	2	2	4	8	8	3-6-6; 5-10-10
16	1	3	3	3	9	9	
17	2	3	3	6	9	9	4-6-6
18	2	5	3	4	10	6	
19	3	4	3	6	8	6	
20	3	4	2	9	12	6	6-8-4
21	1	6	3	2	12	6	
22	1	4	5	2	8	10	
23	1	2	4	3	6	12	
24	3	5	8	6	10	16	
25	1	1	2	5	5	10	

Note: Other ratios may be substituted or added to above list, but when 25 analyses are made in 3 or 4 grades each, depending upon sources of materials, the registrations expand to 100, more or less.

[2] Nearly 8,500 brands and special mixtures were registered during the fiscal year 1938-39.

Field Crops

W. E. Stokes, Chairman

L. A. Alsmeyer
R. E. Blaser
F. E. Boyd
John Camp
C. D. Kime
J. W. Malone
J. Lee Smith
J. D. Warner

Truck Crops

F. S. Jamison, Chairman

F. S. Andrews
Ed Ayers
J. F. Bazemore
J. R. Beckenbach
E. N. McCubbin
M. U. Mounts
W. T. Nettles
J. G. Smith
Alec White

Citrus

H. A. Thullbery, Chairman

Dana G. Coe
E. F. DeBusk
R. S. Edsall
B. F. Floyd
W. P. Hayman
R. N. Hurlebaus
R. E. Norris
F. M. O'Byrne
Ward H. Sachs

Miscellaneous Horticultural Crops

G. H. Blackmon, Chairman

G. M. Hart
T. L. Cain
R. A. Carlton
R. D. Dickey
J. H. Hunter
F. S. Lagassee
S. J. Lynch
C. H. Steffani
W. F. Ward

Orlando, Florida
R. V. Allison, Secretary

SPRING MEETING

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Orange Court Hotel, Orlando, Florida, April 15, 1941
1:30 P. M.

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FURTHER STUDIES OF SOIL REACTION

R. A. Carrigan[1]

At the Tampa meeting of the Soil Science Society of Florida on April 2, 1941, a symposium was held on the subject of "Soil Reaction as a Basis for Certain Land Management Practices." (1) The papers presented at this symposium dealt primarily with the practical problems of obtaining representative samples of soils under Florida conditions and of the routine testing of these samples to determine their pH values. The informal discussion following presentation of the papers led to the appointment by the Chairman of a committee to prepare recommendations for a system of routine collection and testing of soil samples as a public service to individual growers.

As an outgrowth of the symposium, and of the committee's activity, a program was developed to provide for the sampling and testing, for pH value only, of soils from the farms and groves of a large number of clients of the Agricultural Adjustment Administration in certain counties. Three existing agencies have collaborated to make this activity possible. The Agricultural Extension Service, through the activities of Mr. E. F. DeBusk and the county agents, have supervised the field work, including collection, preparation, packaging, and shipment of the samples to Gainesville, together with the assembling of the field notes and reporting of the data back to the growers with recommendations where required. The Agricultural Adjustment Administration has supplied labor for collection of samples and for the laboratory determinations. Technical supervision of the laboratory work has been contributed by the Department of Soils of the Florida Agricultural Experiment Station.

Under this program, samples were taken by the compliance men of the Agricultural Adjustment Administration during their regular visits to the fields and groves of individual cooperators. Brief notes on soil management practices were made at the same time. The samples were taken to the County Agent's office where they were dried, labeled, and packaged for shipment to Gainesville. At the Experiment Station, the samples were tested to determine pH values by an approved laboratory method carried out under rigidly standardized conditions. The method employed (2) depends on the use of the glass electrode. This method

[1] Asst. Soil Chemist, Fla. Agr. Expt. Station, Gainesville.

is now generally accepted as the most suitable for the purpose and is quite fully described in the paper referred to above. After the laboratory tests are run the data are reported to the County Agricultural Agent who passes the information along to the grower.

The information gained in this way is of value to the individual grower as an aid in determining the need of his soil for lime. For the Agricultural Adjustment Administration the program provides a means of determining where benefit payments for liming are appropriate and will, if maintained, afford this agency a means of continuously checking on the effectiveness of this part of their program. The Extension Service and the Experiment Station gain valuable information on conditions in the farm soils of the state. An important advantage of handling the pH-testing of soils in this manner arises from the fact that the samples are taken by workers who are trained in the proper procedure of obtaining samples which are representative of the average soil in the locality under consideration.

The data obtained on soils from groves since the inception of the program in November, 1940 up to March, 1941 are summarized in Table 1 for the four counties in which the largest numbers of samples were taken during this period. The "A" samples represent soil from the areas between the tree rows, while the "B" samples are taken from under the trees; both are taken in the manner decided upon in the course of the Tampa meeting referred to above. The samples from each county are classified into six groups on the basis of the pH values of the "A" samples. The data for each county are arranged to show, in the first horizontal row, what per cent of the "A" samples from that county fell within each of the six pH ranges. Thus 37 per cent of the "A" samples from Highlands County had pH values between 5.5 and 6.0. In the second row, designated *Av. "A"*, the average pH value of the "A" samples falling within each of the six pH ranges is given. For example, under Highlands County, it is seen that the average pH of the "A" samples which fell in the range 5.0 to pH 5.5 is 5.4, indicating that most of the samples in this range were closer to 5.5 than to 5.0. The same information for the "B" samples is given in the third horizontal row, labeled *Av. "B"*. The fourth row, designated "Percent A > B," indicates what per cent of the location had "A" samples with pH values greater than those of the corresponding "B" samples. Thus in Highlands County, the pH value of the "A" sample was higher than that of the "B" sample in 88 per cent of those sampling locations where the "A" samples had pH values lying between pH 6.5 and pH. 7.0.

The table indicates that a large percentage of the groves tested showed pH values which are generally considered reasonably suitable for citrus culture in the sandy soils of Florida. However, the presence of a significant percentage of groves with pH below 5.5 indicates the need for more careful attention to the lime status of their soils on the part of some growers. Very few soils showed pH values above 7.0 although a fair percentage fell in the range from 6.5 to 7.0 where nutritional difficulties may occur.

In agreement with results reported by Peech (3), a pronounced tendency is observed for the "B" sample (under the tree) to be lower in

pH than the corresponding "A" sample. This effect tends to disappear in locations having low pH values, but becomes quite pronounced in the higher pH ranges. This conclusion is true only in terms of the average of a large number of groves. Owing to variations in management practices not considered here, many exceptions should be expected.

TABLE 1.—SUMMARY OF COUNTY pH DATA, NOVEMBER, 1940 - MARCH, 1941.
(Grouped on the Basis of the "A" Samples)

County	Number of Locations	Soil Reaction Relationships	pH Ranges					
			Below 5.0	5.0-5.5	5.5-6.0	6.0-6.5	6.5-7.0	Above 7.0
		*						
Highlands	317	1. Percent A	0.0	6.0	37.0	49.0	8.0	0.0
		2. Average A	—	5.4	5.8	6.2	6.6	—
		3. Average B	—	5.6	5.7	5.9	6.1	—
		4. Percent A > B	—	32.0	61.0	85.0	88.0	—
Lake	205	1. Percent A	1.0	16.0	63.0	20.0	0.0	0.0
		2. Average A	4.8	5.3	5.7	6.2	—	—
		3. Average B	4.9	5.3	5.4	5.6	—	—
		4. Percent A > B	0.0	47.0	75.0	88.0	—	—
Orange	689	1. Percent A	1.0	6.0	40.0	41.0	11.0	1.0
		2. Average A	4.6	5.3	5.8	6.2	6.7	7.3
		3. Average B	5.4	5.2	5.5	5.7	5.8	6.1
		4. Percent A > B	0.0	60.0	78.0	86.0	97.0	100.0
Pinellas	92	1. Percent A	3.0	34.0	49.0	10.0	3.0	1.0
		2. Average A	4.8	5.3	5.6	6.2	6.7	7.1
		3. Average B	4.8	5.4	5.6	5.9	6.4	7.2
		4 Percent A > B	33.0	36.0	62.0	100.0	100.0	0.0

*

1. Percent of "A" samples falling in the various pH ranges.
2. Average pH value of the "A" samples falling in each range.
3. Average pH value of the corresponding "B" samples falling in each range.
4. Percent of locations having "A" samples with higher pH values than the corresponding "B" samples.

REFERENCES

1. ALLISON, R. V., et al. A symposium: Soil reaction as a basis for certain land land management practices. Proc. Soil Sci. Soc. Fla., **2**: 9-44, 1940.
2. CARRIGAN, R. A. Methods of determination of soil pH. Proc. Soil Sci. Soc. Fla., **2**: 25-39, 1940.
3. VOLK, G. M., and M. PEECH. Fastors affecting the soil sampling procedure. Proc. Soil Sci. Soc. Fla., **2**: 12, 1940.

AFTER pH WHAT

G. M. VOLK [1]

Soil scientists began attempts at determining soil fertility by means other than crop response soon after the soil was first known to be a source of nutritive elements. Soil reaction or pH has been recognized for some time as a limiting factor in nutrient availability and has received a great deal of attention during recent years. There is still considerable controversy with respect to methods for its determination and the application of pH data, but in general it is accepted as an important measure of soil-environment for the plant and only the details of practical optimum ranges for specific soils and crops are incomplete.

The progress in the field of estimation of nutrient availability by means of chemical analysis of the soil or extracts of it has not been as rapid and satisfactory as research workers had hoped for or as great as many agriculturists believe. There are two fundamental limiting factors in approaches to this study, which to date have not been satisfactorily eliminated. The one of most concern to soils specialists is their inability to devise a method of extraction of nutrients which will correlate with plant response or growth over a range of soils. Methods that are in use at present require classification of the soils into groups, the members of which are almost identical with respect to texture, organic matter content and solubility of retained nutrients. The amount of nutrient removed by any given extraction procedure must be correlated with crop growth on each group of similar soils. This in itself is not prohibitive to the use of a method. The real danger lies in our inability to classify the soil in question accurately enough to place it in the proper correlation group. Failure to do so means that the set of correlation values does not apply and recommendations based on the analysis are not reliable. This applies in general to all existing extration procedures.

The second weakness of the present approach is the inability to evaluate the variable soil factors in a manner that will permit adjustment of the correlation factors so that they may be applied to soils outside of the class upon which the correlation was originally made. For example, if it were found that there was a consistent correlation between organic matter content and the critical or essential level of a nutrient extracted by any given procedure it would be possible to determine organic matter in an unknown soil and apply the proper correction to change or reevaluate the significance of the amount of nutrient extracted. Or if clay content in the soil could be similarly evaluated it would be possible to estimate the essential level of any nutrient in a loam soil from the known needs of a sandy soil or clay soil. Such is not the case, however. Factors such as soil organic content, texture and fixing power which in part determine the critical or essential levels of extractable nutrients in the soil are so interrelated that only confusion results from attempts to make adjustments of correlation values on the basis of their numerical values obtained by soil analysis.

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[1] Soil Chemist, Fla. Agri. Expt. Station, Gainesville.

The trend in methods of soil analysis for the estimation of fertility has been from drastic digestion of the sample in strong chemicals toward the use of very weak extracting solutions. This has been due in part to the early lack of refinement in rapid methods of determining minute quantities of nutrients such as appear in weak extractants. As late as the 1920's emphasis was still being placed on total or fusion analysis of soils in estimating their fertility. Such data were of certain value, but it was not until dilute acid and salt solution extractions became popular that a real picture of the fixation and solubility of soil nutrients was obtained. The apparent trend toward the use of still weaker extractants has been changed somewhat, because of the popularity of work on methods adaptable to field kit use. These methods usually involve the use of a relatively strong extractant because weak extractants do not remove a sufficient concentration of the element in question to permit estimation by the methods of color or turbidity development to which a field kit is limited. Concentration of dilue extracts is possible with laboratory facilities, and weaker concentrations can be determined accurately with recently adapted photo electric methods of reading intensity of colors or suspensions.

There are certain hazards to be avoided in the use of existing field kits or laboratory methods for the estimation of soil fertility. An experienced grower or field agent has a real insight into the needs of various crops on the different soils of the area with which he is familiar, especially if he is acquainted with the past history of their treatment. A real danger is that practical workers of this type may be influenced by the findings of a chemical soil test to a greater extent than such a test justifies. The test is merely one of the tools available to them as an aid in learning more about the soil and should play a relatively small part in contributing to the final answer to any fertility problem.

As an example of the fallacy of making certain soil test interpretation, assume that eighty per cent of the soils of an area respond to phosphorus additions. Indications are that a calibrated phosphorus test has a probable accuracy of eighty per cent in determining whether or not the soil of an area will respond to additions of phosphorus. Of the twenty per cent error it can be assumed that ten per cent is positive and ten per cent is negative. If phosphorus was applied to all soils in the area the error would be a positive twenty per cent because of additions that were made when not needed. If the soil test were taken as a criterion and phosphorus applied accordingly, the error would also be twenty per cent, but in the former case it would all be positive and maximum yield would be obtained on all soils; while in the latter, the ten per cent of soils erroneously showing high phosphorus by test would receive no treatment and the yield would be low. Thus it would be better to ignore the test than to attempt to use it at its average correlation. If, however, it was determined that the ten per cent of soils showing the highest phosphorus by test had a no response correlation to added phosphorus that approached one hundred per cent accuracy and those occurring in the lowest ten per cent had a positive response also approaching one hundred per cent correlation, the method would be of great help in making recommendations for these extremes.

Unfortunately, in practice, the greatest percentage of soils falls into the intermediate zone where percentage of correlation drops to an unsafe figure if the gamble on crop failure that is taken for the sake of saving the cost of an amendment is considered.

If the value of the soil test as an aid in arriving at a decision in the small percentage of extremes more than offsets the liability of prejudice or bias of judgment within the range of low correlation, then a test is an asset to the investigator. Insofar as considerable experience, both with the crop and the soil, and in the significance of the test for any given set of conditions is necessary, the personal element must be considered as the first limitation in the use of chemical soil tests as they exist today.

The future outlook for soil testing as a means of estimating fertility appears to be tied up with either the development of extraction procedures which will remove quantities of nutrients having the same critical levels over a wider range of soil conditions, or the accumulation of a mass of data on correlation of crop growth with extractable nutrients and recognition of significant factors for determining the limits of the groups to which specific correlations apply.

The first is being attempted in Florida by working with extremely weak extractants using soil to solution dilutions approaching field conditions as nearly as is possible and practical. The information needed in the second is being accumulated by soil analysis conducted in cooperation with crop testing personnel in the state.

THE EFFECT OF SUBSTITUTED CATIONS IN THE SOIL COMPLEX ON THE DECOMPOSITION OF NATAL GRASS [1]

Thomas Whitehead, Jr. [2]

INTRODUCTION

Organic matter content has long been considered an important factor in the actual value of a soil for crop production. It not only affects the physical properties of the soil, but may in many instances prevent the loss of important mineral elements and make them available at a time when plants can utilize them most efficiently. The importance of soil microorganisms in such a cycle of change can readily be seen since they are the machinery by which the soil organic matter is broken down and the nutrient materials required by plants liberated.

The living, dynamic characteristics of the soil and the complexity of its various components present quite serious difficulties in any approach to the development of definite knowledge concerning it. This is well illustrated in the literature on the relation of hydrogen ion concentration to organic matter decomposition and other biological processes commonly occurring in the soil. In studying the relation of hyrogen ion concentration to the proteolytic activity of *B. subtilis*, Itano (4) found minimum, optimum, and maximum pH ranges. Johnson (5) found that pH tends to change toward neutrality upon decomposition of organic matter by soil molds. Albrecht and Davis (1) studied the relation of calcium to the nodulation of soybeans on acid and neutral soils. They found that addition of calcium carbonate to acid soils gave better inoculation of soybeans and better root systems than untreated acid soils. Albrecht and McCalla (2), in a study of the colloidal fraction of the soil as a culture medium, show that the nutrients absorbed by clay may be removed by soil microorganisms and used as a source of food.

In a study of the decomposition of organic matter at different initial pH values Dyal, Smith, and Allison (3) found that plant materials decomposed more rapidly between pH 5.94 and pH 7.05 than between pH 3.71 and pH 4.59. Kononova (6) found that adsorbed calcium, as an exchangeable base, increased the decomposition of organic matter as the pH was increased.

The literature seems to show that there is no close agreement among workers as to the relative importance of hydrogen-ion concentration and the presence of various cations upon the growth of plants or the decomposition of organic matter. In the present study it was thought that by using an artificial medium composed of bentonite clay mixed with sand

[1] Thesis submitted to the Graduate School, University of Florida in partial fulfillment of the requirements for the degree Master of Science. The assistance of Dr. F. B. Smith in outlining the work and in preparing the manuscript is gratefully acknowledged.

[2] Graduate assistant, Soils Department, College of Agriculture, University of Florida, Gainesville.

it would be possible to determine the effect of the various cations such as hydrogen, calcium, magnesium, and barium, singly and in combination, in the exchange complex upon the decomposition of organic matter.

PROCEDURE

The bentonite was elecrodialyzed in a Mattson-type cell for 24 hours to remove the bases present. Portions of the electrodialyzed clay were resaturated with various cations such as calcium, magnesium, and barium. The calcium clay was prepared by adding to the hydrogen clay a quantity of calcium hydroxide sufficient to give 100 per cent saturation of the exchange complex. The barium clay was prepared in a similar manner using barium hydroxide. The magnesium clay was prepared by adding magnesium oxide to the hydrogen clay in the proper amount. The materials were then dried and ground in an agate mortor.

Likewise, various degrees of saturation of the clay complex were obtained by mixing the hydrogen saturated bentonite with each of the several cation-saturated bentonites in the proper amounts. The variously saturated bentonite clays were then mixed with quartz sand in predetermined amounts.

Duplicate one hundred gram portions of the dry, artificial soil prepared in this manner were placed in 500 cc. Erlenmeyer flasks. Two grams of finely ground natal grass were then added and mixed thoroughly with the "soils". To supply the essential elements for growth of the microorganisms a mineral mixture, omittting the cation that was under study in each case, was added to each flask. The mineral mixture contained 0.18 milliequivalents of nitrogen as ammonium sulfate, 2 milliequivalents of potassium as di-potassium phosphate, 2 milliequivalents of magnesium as magnesium oxide, 2.5 milliequivalents of calcium as calcium hydroxide, 1 milliequivalent of sodium as sodium chloride, and a trace of iron as ferric chloride. The flasks were inoculated with 5 cc. of a soil infusion and the moisture content adjusted to 30 per cent. This seemed to provide adequate moisture without completely saturating the medium.

The cultures were then incubated at room temperature and the decomposition of the natal grass measured daily by determining the amount of carbon dioxide produced. This was continued for a period of sixteen days. By that time the rate of evolution had risen to a maximum, and fallen to a constant level in each of the cultures. The pH of the soils in each case was measured at the beginning and at the end of each experiment by means of a glass electrode.

Mixtures of calcium and hydrogen saturated clays were prepared to provide 70, 50, 30 per cent calcium saturation and 100 per cent hydrogen saturation as shown in the tables where the results are recorded. Thus the degree of saturation with calcium varied from 0 to 100 per cent. The amount of calcium supplied in this form, independent of the degree of saturation, was also varied by preparing four series of each system containing 5, 10, 20, and 30 grams of the clay, respectively. This made a set of 20 different "soils".

RESULTS

The data in Table 1 show that the least amount of decomposition of natal grass was obtained in the hydrogen-saturated clay, while the most carbon dioxide was produced in the mixture which supplied only 5 grams of 30 per cent saturated clay. Increasing the amount of calcium in the culture, above a certain minimum, did not bring about an increase in the decomposition of natal grass and at 30 percent saturation of the clay a sufficient level of calcium was present to permit maximum decomposition. Increases in the amount of clay added to the mixtures did not seem to affect the amount of decomposition of natal grass. Table 2 shows that in bentonite mixtures with natal grass as the source of organic matter, the pH varied from 3.26 to 9.04. In the hydrogen saturated

TABLE 1.—THE EFFECT OF AMOUNT AND DEGREE OF SATURATION WITH CALCIUM ON THE DECOMPOSITION OF NATAL GRASS.

Degree of Saturation (Per cent)	Total milligrams of carbon dioxide produced*			
	Grams of prepared bentonite per 100 grams of "soil"			
	5	10	20	30
100	912	1013	707	864
70	1009	937	850	935
50	791	942	899	966
30	1038	844	863	1007
0	393	516	483	494

* 16-day incubation period.

TABLE 2.—EFFECT OF DECOMPOSITION OF NATAL GRASS ON pH OF "SOILS".

Degree of Saturation (Per cent)	Grams of prepared bentonite per 100 grams of "Soil"							
	5		10		20		30	
	pH Before*	pH After*	pH Before*	pH After*	pH Before*	pH After*	pH Before*	pH After*
100	8.6	7.8	8.9	7.6	8.9	7.8	9.0	7.6
70	8.8	7.5	8.4	7.9	8.6	7.9	8.4	7.3
50	7.6	7.0	7.3	7.2	7.2	7.3	7.1	6.3
30	7.0	6.9	6.7	6.3	5.6	6.3	5.9	5.1
0	4.9	5.8	3.9	4.0	3.4	3.4	3.7	3.3

* 16-day incubation period.

bentonite and in the 100 per cent and 70 per cent saturated clays, the pH after decomposition was changed very noticeably from the initial value. The pH was decreased in those soils of initially high pH and increased in those cases where it was low at the beginning of the experiment. The mixtures containing 20 or 30 grams of bentonite did not change the pH as much as the mixtures containing 5 or 10 grams of bentonite per 100 grams of soil. The pH of soils of medium acidity varied only slightly during decomposition.

Mixtures similar to the calcium-hydrogen clays were made with magnesium and barium. Thus three systems of clays were prepared and the degree of saturation with each of the bases calcium, magnesium, and barium varied from 0 to 100 per cent. Ten grams of each clay were mixed with 90 grams of washed sand. Two grams of finely ground natal grass were then added and the experiment carried out in the same manner as with the calcium clays except that in this instance only 10 grams of clay were used. Table 3 shows that less decomposition of natal grass was obtained in the hydrogen-saturated bentonite mixtures than in any of the mixtures with calcium, magnesium, or barium. The decomposition of the natal grass was greater in the calcium clays than in the magnesium or barium-saturated clays.

TABLE 3.—The Effect of Various Degrees of Saturation of Calcium, Magnesium, and Barium Clays on the Decomposition of Natal Grass.

Degree of Saturation (Per cent)	Total milligrams of carbon dioxide produced*		
	Calcium **	Magnesium **	Barium **
100	1013	863	771
70	937	908	821
50	942	715	791
30	844	709	737
0	516	434	474

* 16-day incubation period.

** Ten grams of prepared bentonite per 100 gms. of "Soil."

The data in Table 4 show the effect of the decomposed natal grass on the pH of the different clays. Again it appears to have altered the pH in each of the clays at the extreme ends of the range more than at medium acidities. The tendency was to reduce the acidity at low pH and to increase the acidity at high pH.

The decomposition of natal grass seems also to be markedly decreased at acidity levels between pH 4 and 5. The amount of calcium necessary to bring about optimum decomposition in these experiments was about 2.5 milliequivalents per 100 grams of soil. Magnesium and barium function similarly to calcium in stimulating the decomposition of organic

TABLE 4.—THE EFFECT OF THE DECOMPOSITION OF NATAL GRASS ON THE pH OF DIFFERENT "SOILS."

Degree of Saturation (Per cent)	Calcium		Magnesium		Barium	
	pH Before *	pH After *	pH Before *	pH After *	pH Before *	pH After *
100	8.9	7.6	8.4	8.3	9.4	7.7
70	8.4	7.9	7.1	7.8	8.4	8.1
50	7.3	7.2	5.8	7.1	8.1	8.1
30	6.7	6.3	5.1	6.8	7.2	7.5
0	3.9	4.0	4.0	4.4	4.0	4.2

* 16-day incubation period.

matter in acid soils, possibly by reducing the hydrogen ion concentration of the soil especially at the higher levels.

SUMMARY

A problem that often confronts the grower is how to use the information obtained in technical investigations. The practical applications in the case of the present study are obvious when one considers the important part organic matter plays in determining the physical, chemical, and biological characteristics of soils.

Thus it is quite definitely known that organic matter helps to prevent the loss of several important nutrients from the soil. This it may accomplish in several different ways. For instance, the absorptive properties of the material itself are important in holding the bases or cations that might otherwise be lost by leaching. Likewise, the organic matter of the soil is well known as a source of energy for soil microorganisms which, in turn, fix in their bodies some of the free nutrient materials that might otherwise be lost and hold them in this form for future use by plants.

In this way organic matter may assist the soil to a very notable extent in retaining nutrients since, with its natural decomposition, some of the nutrients are liberated in an available form. Likewise, the production of such compounds as organic acids and carbon dioxide in the course of this decomposition may tend to release certain elements from other compounds that are present in the soil and so render them available for the use of plants. Then, too, there is the direct replacement of nutrient elements retained in this way (base exchange) in the organic matter by other elements such as potassium by calcium, by which potassium is made available for the use of the plant.

Furthermore, it is well known that the decomposition of organic matter tends to alter the reaction (pH) of the soil especially at the extremes of the pH scale. This may be through the production of acids and alcohols, and the release of active bases such as ammonia. The

buffer capacity of the organic matter itself naturally tends to prevent a marked change from the reaction where it is most highly buffered and, in this way, may apperciably affect the final pH of the soil.

From this it would appear that once the optimum conditions in a soil for a particular crop are known (in the instance of this study the content of organic matter and its degree of saturation with lime), it then becomes necessary to adjust the soil environment to that condition, just as nearly as possible, whether this is by the application of additional organic matter and lime or the more effective decomposition of the organic materials already present..

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PRELIMINARY REPORT ON A STUDY OF NITROGEN SOURCES FOR CITRUS FERTILIZATION [1]

Eugene Borda and G. M. Volk [2]

The value of different carriers of nitrogen for citrus fertilization has long been a controversial question, both with respect to availability of the nitrogen supplied and the effect on the supply and availability of secondary elements.

It was with the intention of obtaining more information along these lines that a Research Assistantship was established by the E. I. du Pont de Nemours Company at the Florida Agricultural Experiment Station in the fall of 1936.

Work is in progress at present on three Pineapple, two Valencia, one seeded grapefruit, and four Marsh seedless grapefruit groves. The groves are located in Lake, Orange, Pinellas, Polk, and Seminole Counties. The age of the groves at the beginning of the experiment varied from twelve to eighteen years.

Each grove contains an experimental block consisting of sixteen plots of sixteen trees each. Four plots receive fertilizer treatment No. 1, as given in Table 1, four plots receive treatment No. 2, four receive treatment No. 3, and four receive treatment No. 4. Two plots of each treatment receive an annual application of copper, zinc, and manganese in addition.

The data which appears in the following table is presented strictly as a progress report. Yield figures are for either two or three harvests from each of the eight groves—five orange and three grapefruit—which are believed to be significant. Orange and grapefruit yields were combined by bringing them to a common denominator. Each average yield is computed from the yield of over three hundred trees for either two or three harvests.

No difference in the external quality of fruit from the various treatments has been observed.

During the past fall, maturity determinations were made on Pineapple and Valencia oranges. The determinations were equated to a common denominator as were the fruit yields. The average total solids, per cent acid, and $\frac{\text{solids}}{\text{acid}}$ ratio are shown in the accompanying table. The ratio is lowest in treatment No. 1 and highest in treatments No. 3 and 4.

Considerable caution should be observed in interpreting the data at this stage of the investigation but there is an indication that urea is causing an earlier maturity.

All of the mixtures contain at least two ingredients. In order to better differentiate their effect on maturity, this phase of the work is

[1] Summary of the preliminary report given at the Orlando meeting. A more complete report will be presented upon the completion of the study.

[2] Research Assistant and Soil Chemist, respectively, Soils Department, Fla. Agr. Expt. Station.

TABLE 1.—Outline of Fertilizer Treatments and Preliminary Summary of Results Obtained.

Fertilizer Treatment	Source of Nitrogen *		Average Boxes Per Tree	Maturity Studies		
	Semi-Annual Application of 4-8-8 Mixed Fertilizer	Spring Top-Dressing		Total Solids	Per Cent Acid	Solids/Acids Ratio
1	½ Water-Insoluble Organics ¼ Sulfate of Ammonia ¼ Nitrate of Soda	Nitrate of Soda	4.65	11.11	1.54	7.21
2	½ Urea ¼ Sulfate of Ammonia ¼ Nitrate of Soda	Nitrate of Soda	5.02	11.17	1.52	7.35
3	½ Urea ½ Sulfate of Ammonia	Urea	4.78	11.42	1.49	7.66
4	Same as Treatment 3 but only 80% as much Nitrogen		4.36	11.23	1.46	7.69

* The principal comparison is between water-insoluble organics and urea. The nitrogen in the water-insoluble organics is derived in equal parts from bonemeal, fishmeal, and castor pomace.

All mixtures contain 500 pounds of dolemite per ton.

being broadened out, using only one ingredient in each treatment as the source of nitrogen.

The plots receiving the mineral supplements have not shown increased yields, probably because of the fact that the majority of the groves have received mineral sprays.

The yield of treatment No. 4 is decidedly low. The fact that this treatment receives only 80 per cent as much nitrogen as the other plots indicates that the amount of nitrogen, rather than the source in this instance, is the major factor in determining the quantity of fruit produced.

The various nitrogen carriers have had no pronounced effect to date on soil reaction over and above the effect of the dolomite universally applied to all plots.

Plate counts of soil microorganisms, carried out under the direction of Dr. F. B. Smith, from two Pineapple orange groves have shown more than one million organisms per gram of soil. The source of nitrogen has had no appreciable effect on their numbers. However, a much smaller number of organisms were found in a nearby virgin soil of the same type.

In a Marsh seedless grapefruit grove at Clermont in which no mineral sprays of any kind have been used zinc and manganese dificiency symptoms are very evident in plots not receiving the annual application of mineral spplement. There is no visual difference in the severity of deficiency symptoms in trees receiving different sources of nitrogen. A spectrographic analysis of leaves from this grove will be made in order to determine to what extent, if any, the natural organics supply or aid in the assimilation of zinc, manganese, and copper.

SOME COVER CROP TREATMENTS IN RELATION TO THE YIELD OF VEGETABLES

F. S. Jamison [1]

The story I have to tell is rather a simple one. The work which will be reported was begun almost six years ago. The study was initiated because of the conflicting stories heard concerning the use of various green manure crops. For instance, in one area growers claimed *Crotalaria spectabilis* was an excellent crop to grow preceding tomatoes, while, in another area, growers claimed that tomatoes would not grow well following the turning under of the same cover crop. The Sanford and Hastings areas had tried Crotalaria and found it unsuitable as a green manure crop.

In the summer of 1935, a series of plots was laid out at the Main Experiment Station, Gainesville. Eleven different green manure treatments were included in the test. Each treatment was replicated six times on plots 26 x 37 feet. The plots were randomized so that the results might be statistically analyzed. An aisle four feet wide was maintained around each plot. The treatments used on these plots may be found in the accompanying table. The treatments were cowpeas, velvet beans, soybeans, Sudan grass, natural growth, *Crotalaria spectabilis* and *Crotalaria intermedia.* All these crops were disked into the soil when completely matured.

Additional treatments were *Crotalaria spectabilis* burned *in situ, Crotalaria spectabilis* disked under while in full blossom, mature Crotalaria plus the addition of 10 tons of manure per acre and natural growth plus the same quantity of manure. The green manure or cover crops were planted in June, the first season in early June and in the remaining years just as soon as the vegetables were harvested. The crops were disked under in late November or early December with the exception of those treatments where the crop was either turned under while immature or burned. The following spring, vegetables were planted across all the plots. Usually three different vegetables were planted on each. A detailed record of the yield of vegetables by grade was made and a summary of these records is presented in Table 1.

No attempt will be made to discuss in detail all the results obtained from this experiment. However, it is desired to emphasize the fact that different cover crop treatments have a very definite effect on the yield of the following crops, and that the effect varies with the vegetable crop grown. As can be seen in Table 1, the outstanding treatment is where ten tons of manure is added to mature Crotalaria. This treatment produced the highest average yields of beans, potatoes and tomatoes. Higher yields of peppers were secured where no manure was added to the Crotalaria. The natural growth was one of the poorest treatments. It produced the lowest average yield of potatoes; also next to the lowest of beans and tomatoes. However, peppers did fairly well following this

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[1] Truck Horticulturist, Fla. Agr. Expt. Sta., Gainesville.

TABLE 1.—AVERAGE YIELD OF VEGETABLES FOLLOWING CERTAIN COVER CROP TREATMENTS FOR THE PERIOD 1936-1940.

Cover Crop Treatment	Crops and Yield (Bushels per acre)			
	Beans	Potatoes	Tomatoes	Peppers
1. Cowpeas	248	211	214	180
2. Velvet Beans	253	217	207	162
3. Soybeans	214	216	184	85
4. Sudan Grass	253	215	221	122
5. *Crotalaria intermedia*	243	232	204	121
6. Immature *Crotalaria spectabilis*	259	251	217	100
7. Mature *Crotalaria spectabilis* (burned off)	289	230	206	123
8. Mature *Cortalaria spectabilis*	253	236	223	217
9. Mature *Crotalaria spectabilis* plus manure	281	268	237	145
10. Native growth plus manure	249	235	215	138
11. Native growth	220	208	201	141

treatment. There are several other treatments to which reference should be made. One is *Crotalaria spectabilis*, burned off. Crops maturing early in the season or occupying the soil for only a relatively short period maintained satisfactory yields when planted following this handling of the cover crop but tomatoes and peppers, both rather late-maturing crops, failed to produce satisfactorily.

Cowpeas and velvet beans were not satisfactory cover crops, if measured by the yield of succeeding crops. However, it probably should be noted that both of these covers are quite effective in controlling nut grass. In fact, nut grass has been eliminated from infested areas by maintaining a good growth of either cowpeas or velvet beans on the soil during the summer months.

The information presented in the table shows quite clearly that there is a variation in the yield of vegetables following various cover or green manure crops. In order to determine whether or not this variation might be due, in part, to the total organic material turned under, a record of the material produced on the various plots has been kept. No relationship has been found to exist between the amount turned under and the yield of the following crops.

Undoubtedly the rate of disintegration of the cover crops is an important factor. This factor has not been closely studied thus far in this work. However, the rate of breakdown may in part explain the failure of cowpeas, velvet beans and soybeans. These crops start shedding leaves early in the fall and the vines break down quite rapidly when they are disked under. Sudan grass and immature crotalaria are somewhat slower. The addition of manure apparently hastens the breakdown of mature crotalaria. It is not expected that one may select from these experiments the particular cover crop treatment suited to his soil and crop. However, they do emphasize the fact that, for satisfactory crop production, a good cover crop program must be maintained, and, from the experimental work presented, the most satisfactory one is probably one where the green manure crop is well decomposed immediately preceding the period of most rapid crop growth.

BUSINESS MEETING

Vice-President Dr. F. B. Smith, *Presiding*

Immediately following the presentation of technical papers and the discussion that followed, a business meeting was called at 4:15 P. M.

READING OF THE MINUTES

The reading of the minutes of the Interim Meeting of the Society held in Tampa on April 2, 1940 and of the Second Annual Meeting held in Gainesville on May 29 and 30, 1940, were dispensed with on motion and second from the floor.

CHANGE OF TIME OF ANNUAL MEETING FROM SPRING TO LATE FALL

The first question brought up for discussion was that of changing the time of the regular annual meeting of the Society from spring to late autumn. After numerous advantages of such a change had been suggested and discussed, among them the seasonal convenience of growers and the conversion of membership dues and other activities of the Society more clearly to a calendar year basis, the change was moved by Dr. A. N. Brooks of Lakeland, seconded by Mr. R. S. Edsall of Wabasso, and carried unanimously.

APPROVAL OF COMMITTEE REPORTS BY THE EXECUTIVE COMMITTEE

In the interest of facilitating the review and publication of the reports of the various committees of the Society, authority was sought by the Chair for the Executive Commitee, acting as the Editorial Board under the provisions of the constitution, to do this and the request was granted by motion and second from the floor which was carried unanimously.

APPOINTMENT OF AUDITING COMMITTEE

In view of the decision to change the time of the regular annual meeting to late autumn, it was decided by the Chair, with approval from the floor, to delay the Treasurer's report and the appointment of an Auditing Committee until the December meeting.

REPORT OF STANDING COMMITTEES

Only very brief, informal reports were made, with one exception, by several committee chairman, or their substitutes, with the understanding that more detailed reports would follow in the autumn meeting, at least in the instance of certain committees.

1. Membership Committee, R. V. Allison, Chairman

The Secretary reported an increase in membership in the Society from 375, shown in the Second Proceedings, to 562 as of the date of the present meeting and noted that the membership was becoming increasingly diverse with regard to the profession or calling of those who are becoming intrested in the work.

2. Soil Survey Committee, Senator E. R. Graham, Chairman; Mr. H. I. Mossbarger, reporting

Real progress was reported in the development of interest in a Soil Survey Bill that soon will be introduced into the State Legislature actively in session at the time of the Orlando meetings. Attention was called to the fact that the Secretary of the Society had mailed to each member of the Senate and of the House of Representatives and to each County Agricultural Agent and Vocational Teacher of Agriculture in the State a copy of the propsed law and of the First Proceedings of the Society. In the course of this report and the discussion that followed, it was moved from the floor that a joint resolution be drawn with the State Horticultural Society in support of this Bill by the Resolutions Committee and copies of same be immediately forwarded to His Excellency, the Governor of Florida. Hon. Spessard L. Holland, to Senator Ernest R. Graham and to other State officials.

Only a few weeks prior to the meeting, Senator Graham was appointed Chairman of this important committee with the understanding and consent of Senator Geo. F. Westbrook of Clermont, whose illness prevented his taking the active part he so much desired in the work.

3. Terminology Committee, Dr. Michael Peech, Chairman; Mr. G. M. Volk, reporting

Mr. Volk reported that a list of selected terms in common use in Soil Science had been sent out to about one-tenth of the membership for criticism and comment. A more detailed report will be made at the time of the autumn meetings.

4. Soil and Water Conservation Committee, Mr. George B. Hills, Chairman; Dr. R. V. Allison, reporting

The results of small group meetings held during the year were discussed briefly as pointing to a definite need for public meetings to review all phases of such soil and water conservation problems as exist in the Everglades, in the Kissimmee Valley and, in fact, throughout the State. Particular attention was called to the symposium that is to be held as a part of the meetings of the State Horticultural Society on the evening of April 17, under the title, "The Conservation and Control of Fresh and Underground Waters," which is reported on pages 87 to 97, inclusive, in the Proceedings of that Society for 1941.

By action of the Executive Committee later, the names of Mr. H. A. Bestor, Mr. C. C. Schrontz and Mr. G. E. Ferguson were added to the committee.

5. Fertilizer Recommendations Committee, Mr. W. L. Tait, Chairman

Mr. Tait reviewed briefly the rather extended meeting held by his committee during the morning and invited attention to the detailed report of this meeting that appears elsewhere in the present Proceedings (pp. 6-22).

By action of the Executive Committee later, the name of Mr. L. S. Maxwell was added to this committee.

6. Research Committee, Dr. L. W. Gaddum, Chairman

Upon learning that Dr. Wilson Popenoe of Guatemala was to visit Gainesville in March, a letter was sent to all members of the Research Committee of which committee Dr. Popenoe, himself, is a member, advising of a special meeting to be held in the Student Union Building on the Campus of the University, Gainesville, beginning at 9:00 A. M. on March 27 especially to discuss soils problems of mutual interest to Florida and the several Latin American countries to the south. This, of course, was with the idea of developing the most cordial and effective relationships possible with the workers in those countries engaged in soils research. Chairman Gaddum presided at this meeting which was attended by about 25 committee members and others. A brief report follows:

With the view of using the soils research program now in process of development in Florida as something of a starting point in the discussion, the Chairman asked the Head of the Soils Department of the University to outline this program briefly. This was done under the four following divisions of the Department in which active work has been organized to date: a) Soil Chemistry, b) Soil Microbiology, c) Soil Fertility, d) Land Use. Soil Hydrology and Soil Physics were mentioned as two additional fields of effort in which systematic research and teaching should be developed just as soon as possible.

In reviewing the work, the important physical and biological sequence involving soil and plant relationships on the one hand and, on the other, their relation, in turn, to the nutrition of both animal and man, was kept fully in mind as a simple but valuable basis for orienting our agricultural research program as a whole.

Particular emphasis was given in this discussion to the importance of developing a soil survey program in the State as an all-important, physical background for intelligent and effective agricultural research in general and for research, teaching, and extension work in soils in particular. In view of the basic character of work in this field, this phase of the discussion carried logically over into a review of the reconnaissance and other soil survey work that has been done in Cuba, Porto Rico, and other Latin American countries. This, in turn, served as a basis and background, in its own right, for the discussion that followed of other research activities, past, present and future in those countries.

Insofar as the details of the Florida program in soil research are concerned, the Chairman asked that these be brought together and fully supplemented to the end that a complete and comprehensive statement may be available for review at the time of the next meeting of the committee.

Soil Reconnaissance and Survey Work in Tropical America

The rather detailed consideration that was given to the importance of soil survey work in the tropics brought up the question of the possible availability of the extensive data in this and related fields that have been developed down there by private companies in the past. Dr. Popenoe expressed the thought that quite a large part of this information might be made available for study and publication through the proper channels, especially in view of the rapidly growing feeling of need for help of this nature in those countries. It was recommended that effort be made in the near future to determine whether it could not be arranged to have some of the men who have contributed in an important way to that work review and assemble some of this information for presentation at future meetings of the Society. In emphasizing the importance of agricultural work in the American Tropics, Dr. Popenoe stressed the significant observation that popular unrest, unemployment, and governmental instability in general is usually found to be inversely proportional to the extent and development of good agricultural lands.

Student Exchange and Support

This review of the soil survey and related research work in the tropics quite naturally brought the discussion around to what proved to be the main consideration of the meeting, namely, the great need for trained men, nationals from these various tropical countries, to initiate and assume permanent leadership in the development and maintenance of sound agricultural programs.

Exchange of students as well as exchange of professorships were discussed. It was concluded that it was much more important to bring Latin-American students to the States for training than to send northern students to those countries. This, it was pointed out, is due largely to the fact that the Tropical American students, if judiciously selected, will be more likely to return to their respective countries and become enthusiastic workers for their development for the rest of their productive lives, whereas it is doubtful if our young men would remain down there for any appreciable period and if they do, it is only a very small percentage of them who understand the Latin-American psychology and viewpoint sufficiently well to exercise the type of leadership that is so much needed. As a matter of fact, it was regarded as much more important to have mature workers, especially northern teachers active in course work involving Latin-American students, to go to the tropics for a sufficient period of study to definitely orient themselves in relation to the conditions and problems these students are confronted with in their homelands.

A considerable amount of emphasis was placed, of course, on the very great need for care in the selection of students, especially with regard to their having sufficient definiteness of purpose in coming to northern institutions for training. Naturally this definiteness of purpose should include returning to their native country to labor for its welfare following the conclusion of their training period, and this also was stressed.

The conference was fortunate in that Drs. R. S. Atwood and S. D. Diettrich were able to meet with the Committee and review the work of the Institute of Inter-American Affairs from a number of standpoints. The prospective cost to the student for a year on the Campus of the University of Florida was discussed at some length. The sum of $750.00 was set as a moderately liberal estimate without including any of the several benefits that the Institute might be able to offer which would be helpful in developing funds for this purpose.

Tropical American Participation in Future Meetings

The future programs and published Proceedings of the Soil Science Society of Florida were discussed in relation to their possible value in expanding the interest of Latin-American workers in the development and application of soil science and related agricultural sciences. Suggestions were made as to subject matter, time of meetings and publication of articles or abstracts thereof in Spanish.

The meeting adjourned at 12:00 Noon.

7. Resolutions Committee, Mr. W. F. Therkildson, Chairman; Mr. H. I. Mossbarger, reporting

The Resolutions Committee, through the initiative of Mr. Mossbarger, accepted the responsibility for contacting the Resolutions Committee of the State Horticultural Society and, subject to the approval of that committee, drawing a joint resolution in support of a Soil Survey Bill shortly to be presented to the Legislature by State Senator, Hon. Ernest R. Graham, Chairman of the Soil Survey Committee of the Soil Science Society. The motion for this resolution developed in the course of an extemporaneous report for the Soil Survey Committee by Mr. Mossbarger made in behalf of Chairman Graham who could not be present. The full text of the resolution will be found on page 142 of this Proceedings.

ELECTION OF OFFICERS

The nominating committee appointed at the beginning of the afternoon session by Vice-President Smith, consisting of Mr. H. I. Mossbarger, Chairman, Mr. R. S. Edsall and Dr. W. T. Forsee, Jr., was asked to report on candidates for two offices, namely, Vice-President and a member of the Executive Committee, the latter made necessary by the loss of Dr. Michael Peech.

The committee nominated a single candidate for each office, Dr. J. R. Neller for the former and Mr. W. L. Tait for the latter and then moved that the nominations be closed and the Secretary be instructed to cast a unanimous ballot for each candidate in turn. The motion was seconded and unanimously carried.

INSTALLATION OF OFFICERS

Following the election, Vice-President Smith automatically became President for the new official year 1941, with responsibility for developing a program for the third annual meeting of the Society early in December.

There being no further business to come before the Society, the meeting was adjourned at 5:00 P. M. after calling attention to the annual meetings of the State Horticultural Society that were to open in the same hotel during the evening.

MEETING OF THE EXECUTIVE COMMITTEE

At a meeting of the Executive Committee called by President F. B. Smith immediately following the business meeting, Dr. R. V. Allison was reappointed Secretary-Treasurer of the Society. It was decided at that time to hold the Annual Meeting on the Campus of the University in Gainesville, early in December. A few changes in the membership of certain committees, referred to elsewhere, were made.

General View of the Florida Union — from the Southeast.

ANNUAL MEETING

Gainesville, Florida, December 5-6, 1941
Florida Union
General Program, December 5, 10:00 A. M.

ADDRESS OF WELCOME

MR. H. W. CHANDLER *

Mr. Chairman and Gentlemen:

As has been announced, I am pinch-hitting this morning for President Tigert. While I cannot in any way meet his standards of background, oratorical abilities, strength of voice and so on, I do hope that in a few brief remarks I can make you know how happy he and the University community are to have you with us for this week end and make you feel genuinely welcome to the campus.

Through the kindness of your President, Dr. Smith, and your Secretary-Treasurer, Dr. Allison, I have been given some information concerning the purposes and functions of the Soil Science Society of Florida.

I am particularly impressed by two things which have been brought to my attention. First, the emphasis you are placing on man and his well being; and second, an obvious corollary of the first, the emphasis you are placing on applying your talents to Inter-American relations.

I am impressed by these two things because they remarkably complement the functions of the University of Florida. Nothing can be more important to a state University than that its efforts in improving the well being of its citizens (so many of which are abstract) be evidenced by concrete results.

The University is proud of its program in Inter-American relations. When we share the good results of our work with our Latin-American neighbors, we make our international friendships stronger. This, again, complements in a concrete way the efforts of the University in this important enterprise.

We are glad, therefore, to welcome you to us, to offer our facilities to you in your work and to express appreciation to you for amplifying so satisfactorily the program of our University.

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* Dean of the University of Florida.

THE INTER-AMERICAN PROGRAM OF THE UNIVERSITY OF FLORIDA AS IT RELATES TO AGRICULTURAL EDUCATION AND RESEARCH *

Dr. Rollin S. Atwood [1]

The University of Florida established the Institute of Inter-American Affairs on June 2, 1930, to foster better educational and cultural relations between the countries of the Western Hemisphere. For several years previous to that date various professors, especially in the fields of geography, modern languages, and agriculture, had been engaged in work of an Inter-American nature The Institute was established to give conscious direction to this work and to develop a tangible Inter-American educational educational program which would give a new orientation to our educational program for the Americas, a program which would develop an intellectual interpretation and a sympathetic comprehension of the physical, economic and social conditions and the spiritual ideals and strivings of the peoples of the Americas.

The governing body of the Institute is a Faculty Committee on Inter-American Affairs which controls the policies and program with the guidance and recommendations of an Advisory Council made up of individuals preeminent in their separate fields and especially interested in Inter-American Affairs. The executive officer is the Director, appointed by the President of the University and directly responsible to him and to the Faculty Committee for the performance of his duties.

The Inter-American Program operates through the various colleges, schools and divisions of the University, and has a flexible procedure to facilitate making the necessary adjustments in the various activities included in the program of the Institute.

The program which we have developed during the last seven years has three distinct, although closely related, parts. The first, which I might call the academic program includes courses, curricula, and a program of guidance for Anglo American students and a comparable program for Latin American students. The solution of the problem of training our own students has resolved itself into first, the development of new "group" or interdepartmental majors, and second, into the purposeful re-vitalization of certain courses especially in languages, geography and social sciences. Solving the academic problems of Latin American students has been done in a similar manner although, naturally, the specific courses involved are different. We do not recommend specialized isolated curricula for our students interested in Latin America, nor do we look with favor on specialized curricula for Latin American students. Regular academic work in the various departments, including

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* Presented by Dean Walter J. Matherly, College of Business Administration, in the absence of Dr. Atwood from the Campus.

[1] Director, Institute of Inter-American Affairs and Chairman, Division of Geography and Geology, University of Florida, Gainesville.

adequate training in the languages and civilization of the countries involved, has definitely proved to be the most satisfactory plan.

The second part of our program might be called the non-academic or extra-curricular program to adjust students to the educational and social environment. It applies to Latin American students primarily but, as you will note, it is of peculiar value to our own students. This part of our program centers around an Inter-American section in the University dormitories. Opening in the fall of 1939 for the first time in definite form, the Inter-American Dormitory is proving to be one of the most significant steps in the Inter-American educational program of the University of Florida. Centrally located on the campus, the Inter-American Dormitory in Fletcher Hall holds thirty students, Latin and North Americans, who live in mixed pairs under the guidance of a monitor. In turn they are under the direct supervision of the Director of Residence and the Institute of Inter-American Affairs of the University of Florida. It is interesting to note that there has been competition among Florida students who apply to get into the dormitory with carefully selected students from Latin America. An elaborate program has been developed by the boys in the dormitory. This includes a special class in Spanish which is conducted by some of the Latin American students for the benefit of their North American roommates, and an informal South-North American "bull session" in which Western Hemisphere problems are discussed by attending students. An unusually large number of visits to the dormitory by other students is made each semester. Although English is predominantly spoken throughout the dormitory, Spanish and Portugueses are commonly heard.

The third part of the program is aimed at increasing throughout the State of Florida and the Southeast an understanding and appreciation of the educational and cultural developments in the other Americas. Lectures on Inter-American topics are arranged throughout the state, and extensive lecture tours in the southeastern states have been arranged and speakers from Latin America have been scheduled at more than a dozen colleges and universities. Special Inter-American radio programs have been a feature of our University Radio Station WRUF. An annual high school Spanish declamation contest is sponsored by the Institute of Inter-American Affairs in an effort to stimulate interest in the official tongue of eighteen Latin American Republics. Inter-American exhibits, displays, concerts, contests and competitions have been arranged periodically on the campus as well as at appropriate locations throughout the state. Special service is extended to all schools and Pan-American organizations in Florida to assist them in their Inter-American activities. Finally, as an aspect of this part of the program, the Institute holds periodical meetings, conferences, and round table discussions on Inter-American relations.

As an agricultural state, Florida has a tremendous opportunity to play an even more active part in the long range program for closer relations in the Western Hemisphere. It is often overlooked, especially in times like these, that our own civilization is largely an agricultural one. This is even more true of the other Americas. The present welfare and future prosperity of all the Americas will depend largely on the

development of a mutually advantageous agricultural program. Exchange of agricultural products must be developed and fostered for years to come. During the period of adjustment various methods must necessarily be used to avoid too rapid changes which would result in serious maladjustments. Changes, however, are bound to come and we must be prepared to change with the times. The agriculture of the United States in the future is not going to be like it is now, regardless of the other countries of this Hemisphere.

It is recognized beyond any doubt that any long range program for better Western Hemisphere relations *must* look toward the increase in the productivity, buying power, and standard of living in our neighbor countries. We are interested in seeing that the development is in the interest of the Western Hemisphere rather than European interests. We must contribute scientific as well as financial and managerial assistance. I see definite lines along which the State of Florida can be of special assistance in the development of a mutually advantageous agricultural program for the Americas.

The domestic economy in each of the countries must be improved. An example would be the increase in production and consumption of dairy products which would not only raise the standard of living in some of the Latin American countries but would also help solve the problem of overproduction of certain crops of which there are hemisphere surpluses at present. Another example would be improved methods for carrying over surpluses since there are great fluctuations in the production of subsistence crops in many of the countries. The State of Florida is in a peculiarly advantageous position as far as the United States is concerned to become the training ground for agricultural leaders from Latin America who would come here to study improved methods of Western Hemisphere agriculture. Certainly we are in a much better position to offer such training than the countries of Europe where South American students have gone in the past.

Florida has a unique opportunity of combining cultural and economic relations. Before the war the Germans, with their methodical thoroughness, were the recognized authorities on the plant life of Latin America. Expeditions into new territory had to send their specimens to Germany for identification and classification. Obviously, this gave the technical experts of Germany the first knowledge of new and useful plants in Latin America, and the principal collections of South American plants are in Germany. Latin Americans interested in their flora had to consult German botanical works and botanists. As the basis of agriculture is plants, it follows that Latin-American agriculture is dependent upon German scientists, and the Latin-Americans have come to consider the German herbaria as the great cultural centers for all plant life, as indeed they were.

The United States, and especially Florida, should certainly be a center of knowledge for all plant life in the Western Hemisphere, and it is our responsibility to see that we attain this position. It is our feeling that cooperation with the other American Republics along agricultural lines is desired by all, because, if effective, it will help maintain peace, preserve democracy, and provide the only effective means to defend the

Hemisphere against economic and political penetration by dictator governments.

During the last eleven years we have had a large number of students from other republics of the Western Hemisphere. Scientists from many of these republic have come to the University of Florida to make special investigations and have remained for periods ranging from a few days to several months. Excluding these scientists, but including students here at present, we have had bona fide students from at least fourteen of the twenty republics and nearly all of these boys have either graduated or received advanced degrees. Practically every division of the University has had Latin American representatives, excepting the College of Law. At the moment there are Latin American students on the campus of the University of Florida pursuing courses in Agriculture, in Business Administration, in Architecture, in Engineering, in Education, in Pharmacy, and in Journalism. There are also several students who registered in the General College of the University.

Introduction of Latin American Students

DEAN WALTER J. MATHERLY

It is now my very great pleasure to introduce to you four of our Latin American students who are particularly interested in studying agriculture here at the University of Florida. Following my brief remarks I should like to have each of them say a few words to you regarding his experience and work.

OTTO LYRA SCHRADER is a graduate of the Superior School of Agriculture and Veterinary Science in the State of Minas Geraes where he majored in horticulture and received his M.S.A. He now teaches Portuguese at the University of Florida. He was formerly employed by the Ministry of Agriculture in Minas Geraes, Brazil. He is from Rio de Janeiro. Mr. Schrader.

Gentlemen:

It was with great honor that I received an invitation from Dr. Rollin S. Atwood to come here and tell you about what I have done in the past, what I am doing while in the United States, and what I plan to do when I return to my country.

My home town is Rio de Janeiro, capital of Brazil, where I was brought up and where I had my primary and secondary education. I have always desired and enjoyed country life; therefore, I realized that my vocation was to be in agriculture. After high school graduation in 1934, I went to the city of Viçosa in the State of Minas Geraes to attend the "Escola Superior de Agricultura e Veterinaria." After graduation in 1938, in regard to my outstanding work as a student, the Director of the school invited me to join the professional staff in the Department of Horticulture there. I did not accept this kind invitation because I had already accepted a contract to work as a Technical-Assistant with the "Serviço de Contról do Comercio de Farinhas" of the Ministry of Agri-

culture. I continued working there until September, 1940, when I received the invitation to come to the States as an exchange student, a scholarship granted by the University of Florida through the Institute of International Education in New York City.

Here in the University I am taking graduate work in Horticulture. Soil science has also been one of my greatest interests and I am taking it as a second subject.

I am expecting, and hope, to receive my Master's degree in January, 1942. Afterwards I plan to go back to Brazil and work on research problems in the Agricultural Experiment Station there. Whenever that does happen, I will always be thinking very much about the time when I was in the United States, about the great hospitality of its people, and always will remember with gratitude all the kindness that I was shown by the University and the department staffs with whom I have been working.

For better Inter-American relationships, as far as I am concerned, all of you can be sure to find in me a co-worker and a true friend of the United States. I thank you.

Victor Lionel Guzman is a graduate of the National School of Agriculture and Veterinary Science in Lima, Peru, where he took graduate work in horticulture. He has served as Assistant Instructor in the school from which he graduated, and was recommended for training at the University of Florida by the Pan American Union in Washington. He speaks French, Quechua and English and also knows Japanese. Mr. Guzman.

Gentlemen:

I am going to speak about my work here at the University.

In January of 1940 I finished my studies in the National school of Agriculture and Veterinary Science of Lima. After this I was nominated Assistant in the Chemistry and Soils Department at the Experiment Station of "La Molina," where I was working before coming here.

At the University of Florida, I am a graduate student in Horticulture. My studies will last two years, because I wish to be well prepared and also, because I plan to study many courses in Horticulture.

Dr. H. S. Wolfe, Head of the Department of Horticulture of the University of Florida, has planned my program of studies to continue for two years. This program includes: Pomology, Vegetable Gardening, Seed Production, Feed Preservation, and Poultry Breeding.

I want to express my appreciation to Dr. J. L. Colom, Chief, Division of Agricultural Cooperation in the Pan American Union, Washington, D. C.; to Dr. R. S. Atwood, Head of the Institute of Inter-American Affairs, here at the University of Florida, and to Mr. Manuel Ramiraz, Secretary of the Institute, who have helped me to carry out my plans of study in the United States.

Probably in December, 1943, I shall return to Peru. The government of Peru is sponsoring my studies and they receive reports of my plans and progress from time to time.

I hope to qualify myself to become Head of the Department of

Horticulture and Professor at the National School of Agricultura and Veterinary Science. Thank you.

Ernesto Hastings Cassares is a transfer student from Maryville College, Tennessee. He is a resident of Cartago, Costa Rica and is active in Inter-American relations and Los Picaros activities. He is the son of an American missionary mother and a Costa Rican father. Mr. Cassares.

Friends:

My coming to the United States to study has meant a great deal to me because I feel that this is my second homeland; also, I consider it an opportunity that must be made the most of in preparing myself in the best way possible in my chosen field.

I graduated from the high school in my home town of Cartago, Costa Rica in 1936. Then I worked for a year traveling through different parts of the country. At the end of this period I entered the *Escuela Nacional de Agricultura* near San José, the capital. Soon after I came to the United States and attended Maryville College in Tennessee for a year where I took general basic courses. Here at the University of Florida I am continuing my studies in Horticulture, which is my main field of interest, with special emphasis on fruit and vegetable crop production. This is my third year of studies in this country. After I finish my four-year course in agriculture and have taken some graduate courses, I expect to go back to Costa Rica where I want to help our farmers grow more and better crops and thus improve the quantity, quality and kinds of foods for our people. I feel that this is the basic way to raise the standard of living of not only the Costa Rican people but also of the Central American populace, whom I would also like to help. If you were down in our country you would immediately realize what a serious need there is for this horticultural development.

Personally, I feel that your interest in learning Spanish, your desire to understand our peoples and your willingness to help us solve our problems, is one of the best ways to achieve real and lasting understanding and friendship between our nations, for the progress and peace of all concerned. I thank you.

Joaquin O. Moncrieff studied previously at the University of Havana and at Louisiana State University from which he graduated. He is the first holder of the *David Burpee Scholarship in Horticulture for Central America* and was recommended for this honor by a committee consisting of Dr. Wilson Popenoe of the United Fruit Company; Mr. J. P. Armstrong, President of the International Railways in Central America; and Don Fernando Alvarez Chacón of Costa Rica. Moncrieff is proving himself an outstanding student here at the University. Mr. Moncrieff.

Mr. President, Members of the Society:

It is a pleasure for me to appear before you to say a few words about my being here at the University of Florida.

Before I came to this University, I was working for the United Fruit Company in Guatemala, on banana plantations, in the department of "Sigatoka" control. Sigatoka is one of the diseases of the banana plant.

When I finished my education at Louisiana State University, I went back home to work for the government of Guatemala, and I was appointed Head of the Agricultural Extension Office there. I held that position for four years. Then I went to work for the United Fruit Company where I have been during the last two years.

I was there when they told me about my appointment for the Burpee Scholarship; this was a surprise for me since I did not expect to be in school again.

Here I am studying Soils, Soil Surveying, and Horticulture.

After I finish I will go back to work for the United Fruit Company again; I believe that I will work in soil surveying, something which we need very badly in Guatemala.

I must say that I like this University, and that I am very glad and very happy here. I consider that the courses I am taking here are efficiently taught and that I will be fairly well prepared when I go back home.

It pleases me very much to see the importance that you are giving to the relations between this country and the Spanish speaking countries. I sincerely believe that we need the cooperation of our countries and the United States, especially at this moment when the world is facing such a hard situation.

I was delighted to know that you are giving emphasis to the Spanish language and I wish you to learn it in order that you may understand us better. It is as important to you as it is for us to learn English. I thank you.

SOILS RESEARCH IN RELATION TO FLORIDA AGRICULTURE

Harold Mowry *

In the complex field of soils, soils science and soils research, I, while often confused, will not admit that I am entirely lost, but just somewhat in the predicament of the colored man hunting in the woods who couldn't find his way out. He would not admit that he was lost and covered his confusion by saying, "I jus' don't know all the time precisely where I'se at."

Whether in the soils field this be ignorance or innocence on my part, and on the part of others as well, I am unable to differentiate, but perhaps this mental confusion is in part brought about by the great diversity of soils types, of crops and of variable environmental conditions obtaining in Florida, and again by lack of knowledge or differences of opinion as to the metes and bounds of soils research, of just what it consists, what its primary objectives should be and how they may be attained most expeditiously.

I have long been impressed by the very visible effect in different regions of the imprint of soils on the agricultural populations living upon them. There is a most striking contrast, in the type of homes, barns, improvements, schools, livestock and in the peoples themselves, between areas of highly fertile soils and those of inherently poor soils. Exceptions are to be found, of course, but exceptions only prove the rule. I would call this relationship the "ecology of peoples," a subject certainly as worthy of attention as the ecology of plants or animals, and I have the strong conviction that soils, more than any other one factor of nature, exert the greatest single influence on the well-being of agricultural populations. The correction of handicaps brought about by low soil productive capacity offers a direct challenge to everyone engaged in agricultural research, but perhaps especially to those of the soils sciences.

It goes without saying that most of our Florida soils are not noted for their inherent high fertility, but on the other hand it also must not be overlooked that by various means of crop adaptation and judicious cultural methods the acre return in many instances exceeds that of highly fertile soils of other regions. This condition, however, is not universally statewide and what has been accomplished has not, as it were, been pulled out of the hat, but is a result of long testing, experimentation and research on varieties, adaptation and cultural needs. And it may be added that these past achievements are to be considered as only a beginning in the way of accomplishment.

As a basis of soils knowledge an adequate cataloging of soils and demarcation of type boundaries is an unquestioned essential. Commonly referred to as the soil survey, this phase has been seriously neglected in the state, but has now been resumed in a modest way and if given time its thorough completion may be anticipated. The values, necessities

* Associate Director, Florida Agricultural Experiment Station, Gainesville.

and uses of adequate surveys are too well known and established to require repeating. But it need not be emphasized, classification of soils alone directly and immediately answers few of the perplexing problems confronting the man attempting to wrest a livelihood from the land. Through experimentation, made prior or subsequent to the survey, the determination must be made not only as to adaptation of crops to a specific soil but also as to the mineral and other cultural needs of those crops to make production continuous. Solutions of cultural problems may at best be considered as incomplete or transient; they are seldom final. Owing perhaps to the lowered buffer capacity of most of the state's soils, the depletion or addition of organic materials and the application of chemicals as fertilizers apparently can easily upset the normal or original status of balance with the result that modification of cultural treatment at intervals is not only indicated but required.

We have been too prone in times past as well as present to rely wholly on plant reaction as a indicator of plant needs. I hasten to add that in large measure this probably is as it should be, but paralleling soils studies should bring to light changes that concurrently are being brought about in the soils themselves under varied cultural conditions. Thus not only are plant conditions and soils status correlated but definite knowledge developed on the nearly exact optimum soils condition requisite to optimum growth in the plant. And each of our separate crops apparently must be dealt with as a distinct entity. With our present limited knowledge, we can broadly state that certain of many crops are adapted best to certain soils. Yet, with exception of one or two highly significant instances, little or no information is available as to what is happening in the soils themselves under the varied cropping systems employed and the correlative effect of those systems on both crop and soil.

Is it anticipating too much to predict that soils research can show:

Deficiencies and their correction even before they occur as plant symptoms in the several crops on the numerous soils types?

Definite and conclusive information on the degree of availability of soils minerals, both native and applied, to the various crops in the different soils?

Instead of somewhat hazy reference to the numbers and kinds of microflora in the soil, knowledge that will enable us to profitably cultivate, if the term may be applied, those minute organisms to the advantage of specific crops?

Information whereby deleterious trends in the soils complex may be recognized and ameliorated before crop deterioration points them out?

And also what is to be done about soil conservation in its chemical aspects? Other than by purely physical means of conservation how can that dwindling reservoir of "available" or leachable mineral nutrients actually be conserved? And how can that vast storehouse of "unavailable" nutrient minerals in soils be made "available" in place to plants?

It is said that research uncovers immutable laws governing relationships between factors. These findings are then to be reduced or interpreted that they may be put to usage within the bounds of practicality.

Thus scientific discovery is followed by a practical application. But perhaps the trend has too often been in the opposite direction—by this is meant the after-attempt to determine or explain the fundamental basis underlying a usage already in practice. Specifically, greater strides have been made with the so-called minor element need of plants in the past decade than in all previous history. Plant physiologists by laboratory research had demonstrated most of the essential elements needed for plant growth and yet in our omnipotent wisdom we gave full assurance that only the lack of the three primary plant foods need be considered—the others were required in such minute quantity that those requirements were always satisfied by the traces occurring in nearly all soils. Not until and not before it was demonstrated in the field that applications of those elements to plant or soil corrected numerous plant troubles was there a concerted effort to get basic information on their presence and on factors affecting their availability in the soil.

With soils research, as with all research, imagination, objectivity, initiative and ability of correct interpretation are essential to the development of knowledge that can be resolved to the more or less immediate advantage of the actual tiller of the soil. We require the development of an overall program of sufficient breadth that no region of the state will be neglected, but at the same time of sufficient flexibility and specificity that pressing phases may and will be given deserved attention. And it is expected that such a program will be fully integrated, where need be, with plant or other sciences.

Soils science and plant science to a major degree have developed independently. Each has its followers who would have the condition continue without deviation. Others maintain that plants and soils are so inextricably tied together that all research in the two fields should be of dual nature. Undoubtedly there is a plausible and workable middle ground where each plays its individual role and, where required, the effort is united. Apparently valid argument exists for each school, but for early and applicable results a degree of cooperative effort is essential. Is it possible without entering both soils and plants fields to say where soil fertility ends and plant nutrition begins? Plants may be grown in other than a soils medium and some nutrients may be absorbed by plants through organs or tissues other than roots. Again, through long effort, plant breeders and introducers have bred and selected for an adaptation that the soils researcher could never attain. In turn, causes that have long baffled the plantsman have been determined through soils research.

We hear of the lime requirement of soils. Since when does a soil in itself and of its own need require lime; What is meant, of course, is the response of the plant to the element calcium or to the changed soid condition produced that is involved. Here we have the instance wherein plant science determines the reaction required by the plant and soils science determines the means of attaining it. Each branch has an unlimited number of problems that can and must be attacked and solved individually, but again there are as many requiring united effort for solution.

Florida's agriculture has profited immeasurably through research and it is mainly upon continued future researches that we must rely for fur-

thering the State's agricultural advancement. Previous efforts and results have amply demonstrated the value and application of soils research, and a soils program wisely conceived, adequately implemented, definitely objective and properly integrated with other research fields, where necessary, cannot but repay many fold the cost, the time and the effort expended.

THE RELATION OF SOILS AND SOILS RESEARCH TO CITRUS PRODUCTION PROBLEMS

A. F. Camp[1]

In all Experiment Station set-ups there always arises the question of the boundaries of research fields and human nature being what it is there is a constant tendency to make the individual's field all inclusive. This tendency is evidenced by many things and no better example of the situation is at hand than that found in the field of study involving the mineral deficiencies. The plant pathologist insists that all abnormalities are diseases and consequently come under the handling of plant pathology. Since the evidence of the deficiency is slightly different from the ideal tree, he defines it as a disease and insists that research on it belongs in the field of plant pathology. The plant physiologist on the contrary maintains that the field belong to him on the ground that the evidences of the deficiency are the normal result of the lack of a particular element and if the symptoms did not show up it would be abnormal and, since it is a matter of nutrition, he maintains that it belongs very definitely in the field of plant physiology. The horticulturist or agronomist, depending upon what crop is involved, considers these things a matter of fertilization and claims that at least that portion of the field involved in production and fertilization belongs to his department. The soils man enters the picture by maintaining that the deficiency originated in the soil and consequently the entire field of deficiencies belong to him. The tendency for each division that starts to work on such problems is to set up a complete line-up of groves or plantings and to try to include all of the phases of research work without determining the fitness and training of the personnel. As a matter of fact the problem of deficiencies, for instance, is an extremely complicated one and involves problems in many fields and no one department or man is properly trained to handle the entire situation.

Under the set-up used at the Citrus Experiment Station an attempt has been made to avoid this sort of segregation of work and to use the men involved in the work strictly in accordance with their training. Men trained in soil chemistry and technology are used in soil chemistry and technology and production problems are handled by citrus men who are trained for this work. Because I think perhaps this situation is not well understood, I want to review some of the reasons that we have for the particular way in which the work is handled and in particular, the reasons for segregating the soils work as technical work and eliminating soils men from the handling of groves and other production phases.

Quite often the reason is advanced for expansion of work in one particular technical field that interpretation cannot be properly made unless the entire field is covered. The soils man maintains on the one hand that it is impossible for him to evaluate a soil treatment unless he handles the production end of the problem. In the case of citrus this is

[1] Horticulturist-in-Charge, Citrus Experiment Station, Lake Alfred, Florida.

not, in our opinion, a tenable stand because citrus production is a highly specialized field, as highly specialized as the field of soils, and a well-trained soils man coming to the State and attempting to handle citrus production would find himself confronted with the necessity of either slighting the production end and handling it in a hit or miss fashion, or taking an intensive three or four year citrus production course in order to fit himself for handling the problem. All through the records of citrus experiments evidence of this situation is found. Production is reported from fertilizer or other experiments in terms of pounds per tree, whereas, pounds per tree of fruit means little or nothing in the citrus picture. Prices vary with grades and sizes and where these are not known there is no possibility of judging the value of the treatment. This is becoming increasingly acute and today there are some sizes and grades which cannot be shipped and must be sold at a very large discount to the cannery. We had two fertilizer treatments which did not vary a great deal in production but one crop ran 42 percent to sizes that were not shippable under the present shipping restrictions and the other crop to only 6 to 8 percent. As a consequence the first crop sold at a discount because naturally the cannery knew we could not sell it anywhere else and the second sold at a premium because of its high quality. Production records on a pounds per tree basis did not show a great deal of difference between the two crops. Ability to judge the value of crops is difficult to acquire and requires considerable training. Not only is this a fact but you have the additional problem that many of the factors going into grades and sizes involve other things besides fertilizers and some of these other factors may completely mask the effect of the fertilizer treatment if the production methods are not well applied. Producing citrus is a far cry from producing wheat or corn and involves, for instance, a cimplicated disease and insect spray program, failure in any detail of which may result in crop reduction, third grade or unshippable fruit. Unless all of the factors in production are followed in detail the crop may decline for other reason than improper fertilization and this may lead to grievous misinterpretation of results if the real causes are not recognized. Pointing out one specific case, the addition of magnesium to the soil results first in an increased production and a heavier foliage. Trees deficient in magnesium have little scale problem but after magnesium is applied scales start to increase and unless oil spraying is undertaken promptly in such an experiment there is likely to be a decline in production after the initial rise and it might appear that magnesium toxicity were setting in unless the man supervising the experiment were an experienced citrus production man.

In attempting to solve this situation we set up our plots by conference among all of the technical men involved including soils men, plant physiologists, plant pathologists, entomologists, and citrus production men. After the plots are set up the problems of growing the grove in accordance with the general layout, handling the crop, and interpreting the results are left to citriculturists who are experienced and trained in the field, competent to judge citrus production from a technical standpoint and to apply proper measures for the maintenance of the grove in first-classe shape under the conditions laid out under the experiment.

The soils man devotes himself to a study of the soil in the various technical phases, the plant physiologist to the physiological phases, etc., and none of these men attempt to assume responsibility for the running of the grove as a production problem although all of the data involved are available to him for examination whenever he desires.

Criticism has been made that this reduces the soils man to a secondary position not commensurate with the importance of soils in the picture but as a matter of fact we have found that it has actually increased his value in the picture and his value in the public eye because having been trained in soils, he is able to spend all of his time in his field of training and is able to make tremendous progress rather than having to spend a half to two-thirds of his time being an indifferent citriculturist for which he wasn't trained in the first place. I am going to take the liberty of outlining below some of the fields in which we have found soils research high valuable up to the present time and some of the field in which we expect to obtain helpful and valuable results in the future.

One of the first fields in which we became interested was an evaluation of the soils with which we are dealing in the citrus groves. One of the peculiar things about citrus soils in Florida is that they are rapidly changing in character and their composition as citrus soils is in many cases at wide variance with the virgin soil which was originally put under cultivation. In the sandy soils this is due very largely to the fact that the soils originally contained comparatively little in the way of nutrients and partly because of their very poor buffering. In the coastal regions where heavier soils prior to their planting to citrus were poorly drained and when drained and the surface water removed the soil started oxidizing and changing generally in character. The fact that these soils are not stable and that they are not closely related in composition to the virgin soil from which they were derived has made necessary a great deal of detailed study of the actual character of the soil in citrus groves. Some of this work was set forth in Dr. Peech's bulletin on citrus soils in Florida and if you examine the analyses of virgin soils as set forth in the tables with the analyses of grove soils where citrus has been grown for a number of years, you will see exactly what I am referring to. As a matter of fact our treatments, as far fertilization and pH control are concerned, are very drastic and result in extreme changes in composition and reaction of soils so that when a fertilizer experiment has run for a number of years the interpretation of it has to be based on what the soil is going to be like after it has been in use and not on the figures obtained during the early stages of the experiment. I do not know whether I make this entirely clear but in most of our experiments we find ourselves in this fix. We start with a soil situation which is adverse. We treat the soil in various ways, changing its composition and character in many cases, and arrive at a point where we want to release information to the growers but still far from the point where the soils situation has become thoroughly stabilized with regard to such treatments. An interpretation must therefore be made in conjunction with the soils information so that the recommended treatment will maintain the soil in a favorable condition and not carry it into an unfavorable condition through over correction. I find that this viewpoint is not well understod by men

with conventional soil training. The northern clay loams are relatively stable and this is very true of the clay soils in the west. The top soil is relatively deep and citrus trees in California root down to three to five feet and the soil has changed very little under cultivation for the last 40 to 50 years. This is not at all true in Florida where the root system of the tree is confined largely to the top soil and where the top soil can be drastically changed in three to four months in both pH and composition. As a result of this situation we do a large amount of analytical work and study the changes in soils associated with certain soil treatments both of a fertility nature and of a corrective nature so that we can anticipate results in our plots and not have to wait until the plots have completely stabilized which might take 20 to 30 years. A rather crude example of what I am driving at might be given with regard to the question of recommendations for sulfate of ammonia as a source of nitrogen based on some old experiments. Taking a grove which has been well fertilized and has a relatively high pH, sulfate of ammonia will react beautifully as a soil fertilizer for the first two or three years or until the pH of the soil has been reduced and the reserve of nutrients leached out or absorbed by the tree. At the end of the period the inference from the experiment might readily be that sulfate of ammonia is a highly desirable source of nitrogen. But at the same time the reserve of nutrients in the soil has largely been leached out and the reserve in the tree steadily depleted and an extension of the experiments results in tree decline due to deficiencies. Proper study of the soil changes taking place should have anticipated this and noted the decline in the supply of nutrients in the soil and given warning of future deficiencies without making it necessary to run the experiment for a great many years before finding that the treatment was deleterious. Eamples of this could be manifolded many times from the data already published.

A second field which is of extreme interest to us and of great importance is the question of downward movement of nutrients supplied as fertilizers and correctives. Starting in 70 percent of our acreage with a very light soil that has a light top soil 5 to 8 inches thick and a very much lighter subsoil of indifferent depth and low fertility and combining this with heavy rains makes for an extremely rapid movement downward of fertilizer materials and correctives. The ordinary conceptions of leaching do not apply well to this situation for they do not go far enough to evaluate our conditions. It is entirely possible if not probable that there is considerable alluviation taking place of fine material which moves downward through the sand without actually reacting with it and even if this does not take place, although there is plenty of evidence to indicate that it does, there is a removal from the soils of enormous amounts of fertilizer due to washing rains following fertilizer applications. Various forms of soluble nitrogen, potash, and possibly phosphate are washed right through the soil and out where heavy rains occur shortly after fertilizer applications. An excellent example of this occurred with regard to sulfate of ammonia in one of our sets of plots in which soil analyses were made just before the summer application of fertilizer. The application was made and was in turn followed by about three inches of rain in the next five days. A soil sample taken after the rain showed

less ammoniacal nitrogen than was present before the application was made. That and other evidences indicate that the material was simply washed into the subsoil and out before it had a chance to be reacted on by bacteria or absorbed by the tree. This whole problem of movement of nutrients in our light sandy soils is one of extreme importance because the general concepts of such leaching are so mild as compared with the dastic facts of our situation that the loss of fertilizer is greatly underestimated. With increasing irrigation in the State it becomes additionally important because of the fact that a slight excess in application of water can result in very rapid downward movement of water and consequent leaching of the soil so that there is going to have to be a rather close control of irrigation if it is practiced on a large scale in order to avoid loss of fertility. This loss of fertility in careless irrigation might even be so large as to offset the value of irrigation practices for maintaining trees in good condition.

Perhaps out of our research work will come methods of handling soils which will very considerably reduce these losses by leaching and certainly our recommendations for pH control of the grove soils has resulted in a very material reduction in this regard. It is our hope that soils research will go even further and give us other methods for reducing our losses since at the present time this is the place where the largest proportion of citrus fertilizer goes. In attempting to set up formulas for fertilization a number of operators have very offhandedly set up the equation of fertilizer requirement to include losses by leaching, absorption by the tree and fxiation in the soil. They do not realize apparently that losses by leaching are so large in these sandy soils as to make the other two factors almost of minor magnitude, by comparison. While the absorption by the tree and the pounds of an element to make a hundred boxes of fruit are emphasized, little or nothing is said about the fact that most of the fertilizer goes out through the subsoil to the Gulf or to the Atlantic Ocean as the case may be, and the amount absorbed by the tree and the amount fixed by the soil is a comparatively minor item.

A third field which has ranked high in our soils research at the Citrus Experiment Station has been the question of availability studies. Since copper and zinc as well as manganese and magnesium have been brought into the picture, we have had a series of availability problems confronting us with regard to almost all of our citrus soils. Copper and zinc behave rather peculiarly in soils and need much study from a soils standpoint. Manganese and magnesium leach with great rapidity and manganese in particular, has a tendency to become unavailable due to fixation at high pH levels. In cooperation with the horticulturist and plant physiologist methods of analysis of soils have been worked on in an effort to develop methods which would correlate with tree absorption. We have made some progress along this line as evidenced by the publications. I do not expect too much from this particular line of work because it is very evident from the tree standpoint that two different varieties such as the Marsh Seedless and Duncan on the same rootstocks have radically different abilities to obtain certain nutrients from the soil. The Marsh Seedless, for instance, on rough lemon stock will remove large amounts of magnesium from the soil and not show a marked mag-

nesium deficiency in the tree whereas Duncan trees on the same soil and removing relatively much less magnesium from the soil will be so acutely affected by magnesium deficiency as to almost pass out of production. An attempt, therefore, to carry out these methods of analysis to their final degree so as to approach what some of the idealists have submitted as the answer to the problem, namely, methods of analysis which reflect exactly the tree absorption, would require one set of methods for Marsh Seedless, one for Duncan, and in fact one for almost every variety. This is manifestly rediculous at the present stage of things but methods which are workable, which approximate the absorption by the citrus tree and give some indication of availability are particularly important. Under our set-up this is a three-way sort of thing and we hope that it will eventually lead either to usable methods of soil analysis or usable methods of plant analysis to indicate the approach of deficiencies rather than waiting for the trees to show outward evidences of the actual occurence of the deficiency. In general I would say that we expect considerably less of methods of anayses than many people would like to believe but are continuing the work along this line which was started by Dr. Peech.

The field in which we are more interested with regard to availability is the field of mechanism by which some elements are fixed in an insoluble form or more properly speaking, a form in which they are not available to the trees. There has been a great deal of talk about the effect of residual phosphate left from phosphatic fertilizers. Dr. Peech's work published shortly after he left Florida would indicate that with regard to copper and zinc this role of phosphate is vastly over-rated and possibly the organic matter which makes up most of the colloidal material in the sandy soil is more closely allied with these problems of fixation than is the problem of residual phosphatic fertilizers. This work on the mechanism of fixation may seem to be of academic interest at first glance but in the case of things like zinc and copper is probably the first step toward finding out some method for applying these materials and for their retention in available form. A considerable amount of information having to do with the fixation of zinc by liming materials as well as manganese and copper, has already been brought out but their inefficiency at low pH is apparently of a different character and needs to be further studied.

It has been of interest to me to note the gradual change of viewpoint evidenced by Dr. Peech while working in Florida. Having spent most of his time before coming to Florida in working with soils in which the colloidal material was largely clay he attempted to apply most of these ideas to Florida soils but not always with satisfactory results. What he eventually realized was needed is a study of Florida soils and their organic colloids because in many cases they present radically different problems and sometimes give different results than those obtained on soils containing mainly inorganic colloids.

This whole problem is tied up to another phase of research having to do with the effect of changes which may take place. I mentioned earlier in this paper that Florida citrus soils, as far as the sandy soils are concerned, were not well buffered or well stabilized so that studies of availability are not being made on the stable soil. As a result, a man

may have a grove today in which the soil has a pH of 4.5, a very low supply of nutrients and certain grove characteristics commonly associated with those conditions, and when you come back a year from today the soil may have a pH of 7.5, with a new set of deficiencies apparent in the trees and an entirely different picture as far as production is concerned. As a consequence where soils men in most other states approach problems of availability from an "as is" standpoint, namely, dealing with a soil that is relatively stable, the availability problem in this state must be approached not from that standpoint but from the standpoint of what the soil should be in order to maintain optimum availability. In other words, if there is a certain pH range which favors availability it is relatively easy to adjust the soils to that pH and maintain it. As a consequence, we are attempting in these availability studies to expand the field to a study of all of the possible variations of the soils and to eventually set up not an ideal fertilizer program for the soil involved but an ideal soil condition for the fertilizer involved. In other words, it is our aim to adjust the soil to the point of maximum availability for the nutrients needed by the citrus tree. A long stride in this direction has already been made and I fully expect that tremendous strides in this direction will be made in the future. Under such circumstances, the materials that are to be used in supplying deficient nutrients have to be rated not only on their reaction in the tree but also with regard to their reaction in the soil and their potential use as stabilizers for a very unstable soil situation.

The horticulturist working primarily with the tree could be easily inclined to recommend materials based entirely on immediate tree reaction, whereas, such materials might be very undesirable from a soils standpoint. The problem, therefore, becomes one of determining, in the sandy soils at least, what conditions favor maximum availability of materials and then studying methods of changing soils into this condition and also of stabilizing them at the new condition. This may sound a little far-fetched to those who have worked primarily with heavy soils but I want to point out that it is manifestly impossible to do other than this on the sandy citrus soils if the question of efficiency is to be considered because programs of fertilization that will be effective throughout the range from pH 4.5 to pH 7.5 and do their work efficiently are not likely to be easily attainable. The obvious thing is to bring the soil to a certain standard for which a highly efficient fertilizer program can be set up.

There is another phase of the availability problem that has recently been giving us a great deal of concern and that is the effect of moisture and drouth on the availability of certain elements. We are working now with one problem that is apparently associated with the unavailability of an element during periods of extreme drouth in the spring. Large citrus trees with a heavy canopy of foliage evaporate a tremendous amount of water. This evaporating surface has been greatly increased by improvements in fertilization and consequent improvements in the amount of foliage per tree. Under these conditions relatively short dry periods

in the spring and fall result in the soil under the trees becoming highly desiccated and the absorption system greatly reduced in activity. It seems probable from our work at the present time that certain elements become highly unavailable under these conditions and may even become insoluble. This situation may be aggravated, of course, by unreacted dolomite or lime in the soil but seems primarily associated with a drouth situation. This is going to require a great deal of study and possibly numerous headaches with regard to such grove conditions.

There are many other problems of extreme importance in this field but most of them in one way or another come under the headings listed above. I know of no state where a soils man can do more effective soils work than he can in the sandy soils of the citrus district of Florida. I have heard the argument advanced by soils men many times that the soil was so sandy that a soils man couldn't do very much. In fact that was Dr. Peech's first reaction when he came to Florida. As a matter of fact he found out that he could do more soils work here than could probably be done anywhere else for the following reasons. In the first place, the soils are very lightly buffered and can readily be changed. Allied with this is the fact that the fertility of the soil is mostly concentrated in a thin top layer which can be changed throughout its profile, whereas, in apple orchards of the north or citrus groves of the west trees root down three to five feet and only a small fraction of this layer can be changed in character even over a period of a generation. Here almost the entire fertile layer of the soil can be changed from one end of the pH scale to the other in one year with consequent changes in the supply of nutrients in the soil and the condition of the trees growing on the soil. Secondly, the whole situation is much simplified by the fact that most of the feeding system of the citrus tree is located near the top of the soil and almost the entire zone of feeding can be affected by treatment in a few months. This is drastically different from the situation in most tree crops. Finally, we have a highly reactive set-up in which a citrus tree will show results sometimes within as short a period as 14 days and often within 30 days to a change in soil treatment and extreme differences can be developed in one year's time. It is my personal opinion that the sandy soils of Florida represent the finest place for technical soils research in problems of availability, leaching, and fixation of any place with which I am familiar and it would be my opinion, based on results we have already obtained, that a soils man can do more in a technical way in a few years than he could do in a lifetime on heavier, more highly buffered and deeper soils.

The thing that we are lacking most in the soils picture at the present time is information about the soil itself. Citrus will grow through a wide range of conditions and circumstances providing the place is warm enough. It isn't a problem then of surveying for better soils and moving the groves to them but of staying in the warm places and doing the best we can with the soils we find there. This means that these soils must be studied intensively as soils and all their possibilities evaluated so that

in the end perhaps we may make a new soil type for our sandy soils and maybe we'll call it a "Citrus Soil*".

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* While such a designation might be and, in fact, quite commonly is used for purposes of local discussion or for the popular grouping of soils into more or less economic units, it certainly could not be included in any technical classification of soils for obvious reasons. Indeed, it would place the soil of an abandoned citrus grove in about as embarrassing a position as must have been enjoyed by any one of the twelve men who, alone, in all the world, were one time reputed to be able to understand the intricacies of Dr. Einstein's mathematical treatments — when the Professor chose, suddenly, to change his mind.—Ed. Com.

CHARACTERISTICS OF TROPICAL SOILS SATISFACTORY FOR THE CULTURE OF RUBBER (*Hevea Brasiliensis*)

C. B. Manifold [1]

Normally, the further development of agriculture in tropical Latin America would have been delayed. At present certain natural products badly needed by the United States have been isolated or their supply jeopardized. As a result, the interest of the Western Hemisphere is turned toward the agricultural possibilities and soil capabilities of the undeveloped or partially developed zones of the tropical regions of the Americas.

Much attention in the past has been given to soil characteristics and treatment essential to banana and coffee culture. Within the last two years careful consideration has been given to the practical problems of producing coarse vegetative fibers, drug materials, and rubber—all primarily products of the East. Of these tropical products, crude rubber is of vital importance to the national requirements. Active progress is being made in the establishment of its culture in tropical Latin America.

As the planting of a rubber estate represents a large investment, as high as $400 an acre in some instances, all factors that influence the returns on the investment must be considered. The histories of estates planted on a wide range of soils have convinced planting interests that the selection of suitable soils is of primary concern. Other factors, such as availability of labor; accessibility to cheap transportation; stability of the investment from interference; problems of soil management; and tree disease conditions are also important considerations.

Dr. C. F. Marbut, formerly Chief of the Soil Survey Division in the Department of Agriculture, initiated and organized a method of studying soils suitable for the cultivation of rubber trees. His original analysis of the principles involved has guided and influenced the writer in his examinations.

The approach to the study of such soils in this discussion has been through field examinations. Observations have been made to note the growth habits and rubber yields of the native tree growing on various soil types in its natural home within the Amazon Basin. Other observations have been made of the behavior of planted trees of various ages on numerous estates in rubber-producing regions. From this range of observations, not always well organized, certain criteria regarding the adaptability of soils to the requirements of this plant have been developed. In order to make the study more complete, chemical analyses of selected soil samples supply additional facts; however, their correlation with the objective is not very clear cut.

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PROCEDURE OF EXAMINATION

The approach is that of a reconnaissance soil survey, since usually extensive areas of undeveloped country are to be examined.

The explorer should secure a supply of the most accurate maps available. He should collect all possible information on the geology and physiography of the region. Climate is a major factor in rubber production; hence, it is essential that he obtain information on total rainfall, its distribution, and the nature of winds and storms. Climate and soils are so intimately associated in examining an area for rubber production that a physical study without consideration of climate is of little value.

Examination of undeveloped jungle areas requires sufficient preparation to maintain a party on its own resources. Water routes, where available, provide the easiest means to examine an area but must be supplemented by land excursions that cross from one major stream to another. Profiles of upland soils exposed along stream channels afford opportunities for study.

Within the jungle itself, there is no opportunity to view soil profile exposures. Material brought to the surface by ants and within the roots of windfalls are frequent aids.

Travel is either along native trails or on cleared lines cut on a compass bearing. In unexplored areas it is essential to map the course of travel by plane table. Soil studies are readily made by examination of pits, about three feet deep, dug by a native crew preceding the party leader. The characteristics of the upper soil profile can be accurately studied from the sides of the pit and the nature of the soil to a depth of six feet examined with an auger from the bottom of the pit. By developing a gridiron system of trails and lines, a promising area can be studied thoroughly.

While examining the soil, the forest growth is also observed. The density and size of trees, the adjustment of these trees to the soil, and the general vigor and appearance of trees at various seasons—all tell something about the soil. Trees with wide wing buttresses or trestle-like aerial root systems may be correlated with soils having an impervious zone near the surface. Trees having swollen bases usually are found in locations that are predominantly wet.

Where the area has been opened by roads of various types, the work of the explorer is simplified. Published maps aid in keeping locations identified. Road cuts and embankments with exposed profiles are usually common, especially along railroad lines. There is still need for liberal use of the soil auger and an occasional pit to furnish accurate information of the types and character of soils present.

Soil samples, about one pint or one liter, of each horizon of profiles of major soil types should be collected for laboratory analyses and comparisons.

Very seldom is a large tract found of uniform soils. The explorer will need to select areas having the highest proportion of the most suitable soils. Since his studies will include all soil types, he can usually recommend utilization for various purposes adjusted to the complete estate development.

Shifting the rubber tree from the jungle to the estate has not changed its physical characteristics. It is a hardy tree, that will adjust itself quite satisfactorily to a wide range of soil conditions but thrives best when its requirements are met.

Of the twelve to twenty or more species of Hevea, the species *Hevea brasiliensis* is the major rubber producer of commerce. The studies have been based mainly on the soil requirements of this particular species. Of special interest to the soils man is the fact that the tree has a deep tapering tap root that extends to a depth of ten to fifteen feet if unobstructed. It is believed that the principal function of this root and its laterals is to tap all available water resources. The tree requires a considerable water supply to produce latex in quantity during almost the entire year. The tree is intolerant of shade. The wood is soft and brittle, and the entire tree system is subject to a wide range of diseases. These features must all be considered in selecting a planting site which includes proper soil, topography, and climatic conditions.

THE IDEAL SOIL FOR RUBBER

Rubber being a forest tree does not draw heavily in a mature stand on plant foods in the soil. Soils that have a food deficiency can be readily corrected by the addition of the needed elements. The major considerations in selecting for this purpose, therefore, are physical, for these factors cannot be modified. It has been determined that the highest grade of wild rubber and the largest quantity per unit area are produced on those soils having well-drained, deep, friable, reddish or reddish-yellow clay subsoils.

Each major characteristic of the tropical soil is examined to show its favorable influence on growth of the rubber tree.

1. *Texture*

One of the most important characteristics of a soil is its texture, or the relative sizes of the mineral particles and the relative amounts of these sizes which form the soil.

Residual soils derived from unconsolidated clays and sands or from various rock formations show the same textural relationship in the profile in the tropics as in the temperate zone. The A horizon, or surface soil, is lightest in texture; the B horizon, or sub-soil, is heavier; and the C horizon, or parent soil material, is usually the heaviest in texture. Neither the sands nor the clays in their normal unobstructed development offer a barrier to full development of the tap root. The surface soil for rubber may be light textured, but it is essential that the sub-soil be silty clays or clays. This textural arrangement, combined with granular structure, provides the maximum storage capacity for soil moisture and is particularly necessary in regions experiencing dry periods of from three to six months. This condition assures the tree its moisture requirements for satisfactory yields and development. Light-textured sub-soils favor the rapid spread of certain types of root diseases.

2. *Color*

Color in soils is an indicator of the amount and character of organic matter they contain, but of greater significance it indicates the degree of aeration and completeness of oxidation in the soils. The surface soil color is examined mainly for the presence of organic matter and the subsoil is studied carefully to determine the completeness of oxidation.

Normal tropical soils developed under rain-forest cover have little organic matter—only enough to add a brownish color to the surface. Dark-colored soils are often found in the forest at sites of old cultivation. However, this dark color is more from organic stains than from true organic matter. Soils developed from volcanic material in western Guatemala are almost black in color, not due to the presence of organic matter but to the color of the mineral.

Bright-colored soils, such as reddish-yellow and red, indicate full aeration with good drainage and the absence of ground water. These soils develop in smooth upland areas. Grayish and mottled gray and brown soils indicate partial or complete water-logging at some period in their development. The lower alluvial soils and flat upland areas of clay soil usually show the marks of incomplete oxidation and a relatively high water table during the rainy period.

The tap root of the rubber tree will not penetrate the water-logged zone to any degree. Trees planted in poorly oxidized or badly drained soils often make good growth during the first four to eight years but under production begin to drop back, both in yield and vigorous resistance to diseases. Retardation of root development with limted mineral food in unoxidized soils and poor moisture relationships are also handicaps. Well-drained alluvium will support good growth even if subjected to inundation for short periods. In all cases drainage in the surface five to six feet should be good.

3. *Structure*

Structure refers to the size and shape of the groupings of the soil particles. It is the characteristic which determines the "body" of the soil or its "mellowness". Severely leached soils are single particles, incoherent, such as sand and silts with a loose or ashy feel. Normal soils with a certain amount of alkalis and alkaline earths have aggregates of soil particles or granules. Other structural conditions are tough, plastic clays and hardened zones and concretionary layers.

The friable granular soils are most desirable for rubber. Full opportunity is provided for the best relationships between the root system of the tree and the moisture and mineral plant food resources of the soil.

Soils with loose single-grain structure permit good root penetration but lack adequate water-holding capacity and are low in ferftility due to excessive leaching.

Physical barriers to normal root development are formed by zones of tight, tough clays and impervious hardpans or cemented layers of concretionary iron material. The clays may be deposits which have not yet weathered or oxidized sufficiently to permit storage of moisture or penetration by roots. The hardpans and concretionary zones are the products of the deposits from minerals in soil water which later oxodize

and harden. Soils over these deposits are usually highly leached. If these indurated layers occur within five to six feet of the surface, they form a definite barrier to proper root development and restrict the feeding zone of the tree. Long dry periods are particularly harmful to growth on these soils. Some clay and hardpan zones are shattered or softly consolidated and can be penetrated by the tap root. An examination of root behavior is essential where this condition is found.

Natural grassland areas, or "campos", should be avoided for rubber. These areas are characterized by soils that are deep, drouthy sands, shallow over rock or hardpan, or poorly drained. Nature has indicated that these areas are adapted only to grass and shrub types of vegetation.

4. *Fertility*

Tropical soils are notoriously low in both organic matter and mineral plant food. Tropical heat and warm rains both tend to break down the forest floor accumulation and, with the formation of organic acids, the soils are constantly being leached. Field tests of the pH of various horizons are helpful in estimating the degree of leaching and the relative availability of mineral plant foods. The higher reaction (pH) values indicate higher fertility values. Under forest conditions the tree will generally find adequate plant food in a well-oxidized soil of correct structure having suitable soil moisture relationships. Clearing, burning, and cultivation will result in structural changes and destruction of active soil-forming processes and organisms.

The planter will depend on artificial fertilization of the soil for best uniformity in the development of the estate. Newly-planted trees and cover crops are fertilized to aid their rapid adjustment. Trees in less favorable physical sites are fertilized to replace deficiencies in the natural system, which may be a light-textured soil, a reduced feeding zone because of leached and poorly drained soil or a shallow soil over a hardpan, or plantings on an old cultivated area in which most of the natural soil micro-organisms and meager soluble plant foods have disappeared.

CONCLUSIONS

Groups interested in the development of areas for rubber production do not make casual selections for lands on which a large investment is planned. The native of the forest has been guided in his selections of land for cultivation by generations of experience. Those who examine lands for rubber have as their guides the characteristics of the rubber tree, together with an understanding of physical sciences as they are related to the soil. The study being of a reconnaissance nature requires that the significant features found need to be assembled and then carefully analyzed to reach the most practical conclusions. Rubber will grow almost anywhere within the tropical zone providing there are sixty inches or more of rainfall. But the problem of the examiner is to determine where it will grow best within the areas available.

To one who enters the thinly settled forests of the tropics there is offered an enviable opportunity. The job requires concentration and alertness. Observations are being made constantly. The study of the soil and its relationships with the cover which it supports often provides the basis for a sound understanding of the people and their culture.

CARACTERISTICAS DE LOS SUELOS TROPICALES SATISFACTORIOS PARA EL CULTIVO DEL CAUCHO
(Hevea Brasiliensis)[1]

C. B. MANIFOLD.[2]

En tiempos normales, el desarrollo de la agricultura en la América Latina, habría sido retardado. Actualmente, ciertos productos naturales de urgente necesidad para los Estados Unidos, han quedado aislados, o su importación es muy defícil. Como resultado de ésto se ha despertado en el Hemisferio Occidental, un verdadero interés por el conocimiento de sus posibilidades agrícolas y la capacidad de los suelos de las zonas parcial o totalmente desarrolladas, en las regiones tropicales de las Américas.

En el pasado se dió mucha atención a los caracteres de los suelos y a su tratamiento para el cultivo del banano y del café. Pero durante los dos ultimos años, esta atención ha sido diriga a otros problemas practicos, ellos son: la producción de fibras vegetales ordinarias, de drogas y de caucho—materias primas del Este. De estos productos tropicales, el caucho crudo es de primordial importancia para las necesidades de la defensa nacional. El establecimiento de su cultivo esta progresando activamente en el trópico de América Latina.

Como el establecimiento de una plantación de caucho representa una inversión fuerte de capital—$400.00 por acre (4047 metros cuadrados) en algunos casos—la consideración de todos los factores que influyen en las ganancias sobre ese capital invertido es necesaria. La experiencia en plantaciones de caucho hechas en una gran variedad de suelos, ha convencido a muchos interesados sobre la importancia que tiene la selección del suelo para su cultivo. Los otros factores que merecen considerarse son: gente disponible para el trabajo, facilidades de transporte, estabilidad de la inversión sin interferencias ajenas, problemas en el manejo del suelo y enfermedades que puedan atacar al árbol.

El doctor C. F. Marbut, últimamente Jefe de la División de Investigación de Suelos del Departamento de Agricultura, inició y organizó un método para el estudio de suelos para caucho. El análisis original de los principios considerados en este estudio, ha servido de guía y ha influenciado la opinión del que escribe, en los exámenes que ha efectuado.

El estudio de suelos para caucho en esta discusión, es producto de exámenes realizados en el campo. Se han observado los hábitos de crecimiento y producción de árboles silvestres crecidos en diversos suelos del Amazonas, lugar de origen del caucho. En numerosas plantaciones de las regiones del caucho, se ha observado la manera de crecimiento de árboles de distintas edades. De estas numerosas observaciones, no siempre bien organizadas, se ha establecido cierto criterio relacionado con los suelos para caucho. Para hacer el estudio mas completo, los

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resultados de análisis químicos de muestras de suelos seleccionados, proporcionan datos adicionales: pero su relación con el objectivo, aún no ofrece mucha claridad.

PROCEDIMIENTO EN EL EXAMEN

El principio es el mismo empleado en el reconocimiento de suelos para su clasificación: generalmente se examinan extensiones grandes e inexploradas. El explorador debe proveerse de mapas que merezcan confianza: debe adquirir toda información posible referente a la geología y fisiografía de la región. El clima es un factor determinante en la producción de caucho. por consiguiente es esencial averiguar la cantidad total y la distribución de la lluvia durante el año: la intensidad y la época de los vientos y la posibilidad de ciclones. El clima y el suelo están tan intimamente asociados en el exámen de un area para caucho, que el estudio físico del suelo sin considerar el clima, seria de muy poco valor.

El exámen de areas en una selva inexplorada requiere suficiente preparación para mantener al grupo de exploradores con sus propios recursos. Los cauces de agua. si los hay. proporcionan uno de los medios mas fáciles para el exámen de un area. pero debe completarse con excursiones a través del terreno o area comprendida entre cauces principales. Perfiles de terrenos altos. expuestos a lo largo de los cauces, son una buena oportunidad para el estudio.

Dentro de la selva misma no hay oportunidad de examinar perfiles expuestos, pero la tierra traida por las hormigas a la superficie y la que contienen las raices de árboles derribados por el viento, son frecuentemente una ayuda.

La travesía en la selva se hace por veredas ya existentes, o por brechas abiertas después de haber sido trazadas con la brújula. En areas inexploradas conviene levantar un plano o mapa de los lugares por donde se camina, para ello se hace uso de la alidada. Los estudios del suelo se facilitan haciendo hoyos de tres pies de profundidad, cavados por peones que preceden al jefe de los exploradores. Los caracteres del perfil superior del suelo se estudian en las paredes laterales de estos hoyos, y la naturaleza del suelo, hasta una profundidad de seis pies, puede estudiarse por medio de un barreno, perforando en el fondo de los hoyos. Este exámen de suelos debe hacerse en el terreno bajo un plan determinado, por ejemplo, formando una cuadrícula: las veredas o las brechas constituyéndo las lineas en una dirección son atravesadas por líneas imaginarias que pasan por los hoyos.

La vegetación de lugar debe ser estudiada juntamente con el suelo. La densidad del bosque, el tamaño de los árboles, su adaptación al suelo y su apariencia y vigor durante las diferentes estaciones del año, reflejan algunas propiedades del suelo. Arboles con grandes raices aéreas pueden ser la indicación de una capa impermeable a poca profundidad de la superficie del suelo. Arboles hinchados en su base se encuentran generalmente en sitios muy húmedos.

En areas abiertas por carreteras o caminos de varias clases, el trabajo del explorador se simplifica mucho. Los mapas publicados le son de gran ayuda para la localización de esas areas. Los perfiles del suelo

están comunmente expuestos en los cortes de carreteras, especialmente a lo largo de lineas ferreas. Empero, el uso liberal del barreno y la apertura de algunos hoyos, es indispensable para obtener información segura de los diversos tipos y caracteres de los suelos presentes.

En suelos tipicos conviene adquirir muestras de tierra, tomando de medio a un litro de cada estrato, para mandarlas analizar al laboratorio y hacer comparaciones.

En una extensión grande de terreno, rara vez se encuentra uniformidad en sus suelos. El explorador tendrá que elegir areas que tengan la mayor proporción de suelos propios para el caucho. Como en sus estudios incluirá todos los diferentes tipos de suelos de un area, él puede recomendar los diversos usos que pueda darse al area total.

REQUISITOS DE LOS ARBOLES DE CAUCHO

El arbol de caucho no cambia sus caracteres fisicos cuando se le traslada de la selva a la plantación donde se cultiva. El árbol es capaz de adaptarse a muchos suelos y condiciones de los mismos, pero prospera mejor en aquellos lugares que reunen las condiciones que le son favorables.

De las doce a veinte o mas especies de Hevea, la especie Hevea Brasiliensis es la de mayor producción commercial; los suelos que esta especie requirere son los que mas se han estudiado. De especial interés para el hombre de suelos es saber que este árbol tiene una raiz pivotante profunda, capaz de penetrar de diez a quince pies de profundidad si no encuentra obstáculos en el suelo. Se cree que la función principal de esta raiz y sus laterales es horadar todos los recursos de agua. El árbol requiere gran abastecimiento de agua para producir gran cantidad de latex para todo el año. El árbol no tolera sombra. La madera es suave y frágil; todas las partes del árbol son susceptibles a muchas enfermedades. Todas estas condiciones deben ser consideradas cuando se hace la elección del sitio para la plantación, incluyendo suelo apropiado, topografia y condiciones climatéricas.

SUELO IDEAL PARA EL CAUCHO

El caucho, siendo un árbol forestal, no extrae del suelo gran cantidad de fertilizantes cuando llega a su madurez. Si el suelo, carece de algunos elementos quimicos, se corrige facilmente agregándole esos elementos. Al elegir un suelo para caucho, debe darsele especial importancia a sus propiedades fisicas, que no son siempre fáciles de modificar. Está determinado que el caucho de mas alta calidad y de mayor producción por unidad de area, obtenido de árboles silvestres, procede de suelos que tienen un subsuelo de arcilla roja o amarillo-rojiza, bien drenado, profundo y friable.

Cada uno de los caracteres principales del suelo tropical se examina para mostrar su influencia, favorable o desfavorable, al crecimiento del árbol de caucho.

Textura

Uno de los caracteres mas importantes del suelo es su textura, o tamaños relativos de sus partículas minerales y cantidades relativas de cado tamaño presente en el suelo.

En la zona templada, los suelos residuales derivados de arcillas y arenas no consolidadas o derivados de varias formaciones de rocas, muestran en sus perfiles relaciones de textura iguales a las de los suelos del mismo origen en el trópico. El estrato A, o suelo superficial, es el mas ligero en textura; el estrato B, o subsuelo, es menos ligero en su textura; y el estrato C, o material de origen, es el de textura mas pesada. Las arcillas y las arenas normalmente sufren transformaciones, pero ello no constituye un obstáculo para el completo desarrolo de la raiz pivotante. El suelo para caucho puede ser de textura ligera, pero el subsuelo conviene que sea harinoso-arcilloso o arcilloso (*). Esta clase de textura combinada con una estructura granular, provee el máximum de acumulación de humedad en el suelo, factor aun mas importante en regiones que sufren de tres a seis meses de sequedad. Esta condición asegura para el árbol suficiente humedad para su completo desarrollo y alta producción. Los subsuelos de textura ligera favorecen el esparcimiento de ciertos tipos de enfermedades que atacan las raices de los arboles.

Color

El color de los suelos es no solo un índice de la cantidad de materia orgánica que contienen, sino que indica su grado de aereación y completa oxidación, factores, estos dos últimos, de gran significado. El color del suelo se examina primordialmente para juzgar su contenido en materia orgánica; el color del subsuelo se estudia cuidadosamente para determinar su grado de oxidación.

Suelos normales en el trópico, formados en las regiones cubiertas de bosques, tienen poca materia orgánica—suficiente solo para darle un color café (color de tabaco) a la superficie. En los sitios del bosque cultivados antaño, se encuentran suelos de color obscuro, pero esta coloración es debida mas a manchas de orígen orgánico que a vedadera materia orgánica presente. Algunos suelos de orígen volcánico en la parte Oeste de Guatemala, son de coloración casi negros, pero no debido a la presencia de materia orgánica sino que al color de los minerales que los componen.

Suelos de colores vivos tal como amarillo-rojizos y colorados, indican completa aereación con buen drenaje y ausencia de agua subterránea cerca de la superficie. Estos suelos tienen su origen en terrenos altos y de superficie uniforme. Suelos grises y suelos moteados de gris y café, indican estancamiento parcial o total de agua, durante algún período de su formación. Los suelos aluviales bajos y los terrenos altos, planos, de suelo arcilloso, generalmente muestran signos de oxidación incompleta y un alto nivel de agua subterránea durante el tiempo de lluvias.

La raiz pivotante del árbol de caucho no penetra las zonas de agua estancada. Los árboles plantados en suelos pobremente oxidados o con mal drenaje pueden crecer y desarrollar bien durante los primeros cuatro a ocho años de edad, pero en cuanta llega la época de producción, empiezan a declinar, tanto en su producción como en vigor y resistencia a

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* Nota del traductor.—Silt está formado por partículas minerales muy pequeñas (0.05 a 0.002 mm. U. S.) (0.02 a 0.002 mm. sistema Internacional); al tacto dan la sensacion de harina; a esta propiedad se debe que las llamo HARINAS. El nombre de aluvion o cieno que algunos autores le dan a silt, no corresponde por cuanto a que aluvion y cieno contiene silt en mas a menos cantidad, pero no son silt.

las enfermedades. El desarrollo retardado de las raices en un suelo no oxidado, pobre en elementos minerales para la planta y de escaza humedad, constituye un impedimento para el crecimiento del árbol. Suelos de aluvión, bien drenados, favorecen unbuen crecimiento, aún cuando estén sujetos a inundaciones durante períodos cortos. En todo caso, el suelo debe tener buen drenaje, por lo menos hasta una profundidad de cinco a seis pies.

ESTRUCTURA

Estructura se refiere al tamaño y forma de agrupamiento de las partículas en el suelo. Esta propiedad determina el "Cuerpo" del suelo o su grado de desmenuzamiento. Los suelos severamente lixiviados son de estructura simple o partículas simples no unificadas, incoherentes; como ejemplos tenemos: las arenas y las harinas (silts) que, al palparlas, dan la sensación de granos sueltos o la de ceniza. En los suelos normales que contienen substancias alcalinas o alcalinoterreas, las partículas se unen entre si formando agregados o granulos: estructura granular. Otros tipos de estructura son: arcillas plásticas, tenaces; zonas compactas y estratos concrecionados.

Los suelos de estructura granular desmenuzable son los mas recomendados para el caucho; en ellos las relaciones entre el sistema radical del árbol, la humedad y el contenido de fertilizantes están generalmente bien equilibradas.

Los suelos sueltos de estructura simple permiten buena penetración a las raices, pero su poder retentivo de humedad es muy pobre y la fertilidad es dudosa debido al exceso de lixiviación que en ellos tiene lugar.

En algunos suelos existen: zonas endurecidas de arcillas compactas; estratos formados de concreciones de minerales de hierro que se han cementado; o estratos impermeables de otro origen. Las arcillas pueden ser depósitos todavia no meteorizados u oxidados lo suficiente para permitir el almacenamiento de humedad o ser penetrados por las raices. Las concreciones y los otros estratos impermeables son el producto de minerales depositados en el agua del suelo que mas tarde se oxidan y endurecen. Los suelos que están encima de estos depósitos son generalmente muy lixiviados. Estas zonas impermeables, cuando ocurren a una profundidad de cinco a seis pies de la superficie del suelo, constituyen una barrera para el desarrollo de las raices del arbol, además, el area disponible para la alimentación de la planta es muy reducida. Largos períodos de sequedad son muy perjudiciales en este tipo de suelos. Algunas veces las zonas arcillosas y los estratos endurecidos presentan grietas o reblandecimientos que dejan penetrar las raices; en estos casos conviene siempre examinar la manera de conducirse de las raices en su desarrollo.

Los campos cubiertos de gramíneas naturales, sábanas o llanos, no son recomendables para caucho porque sus suelos corresponden a uno de los siguientes grupos: profundos, a arenosos y áridos; o poco profundos, asentados sobre roca o sobre un estrato impermeable; o carecen de buen drenaje. La naturaleza misma indica que estos suelos son propios para gramas o plantas semejantes y arbustos.

FERTILIDAD

Los suelos del trópico son notablemente pobres en materia orgánica y en fertilizantes. El calor del trópico y las fuertes lluvias tienden a transformar repidamente la material orgánica acumulada en los suelos de los bosques, y con la formación de ácidos, orgánicos los suelos son constantemente lixiviados. La determinación del pH, hecha en el campo, de varios estratos del suelo, ayuda a estimar el grado de lixiviación y la cantidad relativa de minerales disponibles para alimento de la planta. Los pH altos indican valores altos de fertilidad. Bajo las condiciones del bosque, el árbol generalmente encontrará cantidad adecuada de alimentos, en un suelo bien oxidado, de estructura favorable y con suficiente humedad. El desmonte, la quema y el cultivo tienden a cambiar la estructura del suelo, destruyen los procesos activos de formación de suelos y a los organismos.

El agricultor deberá emplear abonos artificiales para obtener un crecimiento uniforme de su plantación. Los arboles recien plantados y los cultivos empleados para cubrir el suelo se abonan para acelerar su adaptación. Los árboles plantados en suelos de condiciones físicas no muy favorables, se abonan para reemplazar las deficiencias en su sistema natural de alimentación; estas deficiencias pueden ser debidas a que el suelo sea de textura muy ligera, o también, a que la zona de alimentación sea muy reducida como consecuencia de mucha lixiviacion y mal drenaje, o de un suelo poco profundo asentado sobre una capa impermeable; o que el terreno carece de microorganismos naturales del suelo, los cuales han desaparecido juntamente con los últimos vestigios de elementos fertilizantes solubles, después de muchos años de cultivo en ese suelo.

CONCLUSIONES

Los interesados en el desenvolvimiento de areas para la producción de caucho, no eligen al azar los terrenos para los cuales una fuerte inversión de capital se ha planeado. Los nativos de las zonas forestales eligen sus terrenos guiados por muchos años de experiencia. Los que examinan terrenos para caucho tienen como guía: las características del árbol de caucho y buen conocimiento de las ciencias físicas relacionadas con los suelos. Siendo éste un estudio de reconocimiento, conviene reunir todos los factores de mas importancia y analizarlos cuidadosamente para llegar a las conclusiones mas prácticas. El caucho crece en cualquier lugar dentro de la zona tropical, siempre que la cantidad de lluvia sea de sesenta pulgadas o mas anualmente. Pero el problema del examinador es determinar en dónde crecerá mejor, dentro de un area disponible.

Las poco pobladas regiones forestales del trópico ofrecen una envidiable oportunidad para el que llega a trabajarlas. El trabajo requiere dedicación, actividad y constante observacion. El estudio del suelo y sus relaciones con la vegetación que soporta, frecuentemente son la base de una comprensión sana de la gente y de su cultura.

TERMINOLOGY OF SOIL CLASSIFICATION IN THE SPANISH LANGUAGE [1]

DR. WILSON POPENOE [2]

Few advances have been made in tropical agriculture during the past quarter of a century which have had such far-reaching effects, such tremendous practical value, as the use of soil surveys. One has only to cite, as an example, Bennett and Allison's "Soils of Cuba", a work used not only by technical men throughout the Island, but by practical agriculturists as well.

There is need for a vast amount of similar effort in the tropical republics. It is, unfortunately, a task which involves a great amount of drudgery and which, to some investigators, does not seem to have the appeal possessed by laboratory research. But its value is beginning to be recognized widely, and we can expect that soil surveys of many important tropical agricultural regions will be completed within our own time.

In this connection—and in connection with soil studies in general—there is one point which is troubling many workers in the Spanish-speaking countries. This is the lack of uniformity which exists with regard to Spanish equivalents of English terms used in soil classification.

In undertaking soil studies in the tropics, Spanish-speaking investigators have usually based their activities on the work of British and North American soil scientists. They have adopted the classification of soil textures used by these, attempting, quite logically, to translate literally the terminology into their own language. Different workers, in different regions, have interpreted these terms in different ways. This has made it hard, in some instances, for workers of one region to use the results of workers in other parts of tropical America.

It is doubtless premature to attempt a codification of the Spanish terminology which will prove acceptable to all Spanish-speaking workers in the soil sciences; but the sooner a start is made, the sooner uniformity will be achieved.

Colombia, Cuba and Puerto Rico are three tropical countries in which soil science has made progress. It was therefore considered worth while to compare the terminology used in these three as a beginning toward clarification of the subject. A list of English terms for soil separates and soil textures was submitted to Dr. J. A. B. Nolla, Director of the Insular Experiment Station, at Rio Piedras, Puerto Rico; to Dr. Eduardo Mejia Velez, Director of Agriculture at Bogota, Colombia; and to Dr. José M.

[1] This paper was prepared by Doctor Popenoe subsequent to the December meetings of the Society and is presented as a basis for discussing the Spanish translation of certain terms in common use in soil classification. This is being done especially with the hope of eventually developing a uniform set of Spanish equivalents for the very great convenience it would afford in future discussions of soil science problems in this field on a bilingual basis. It is hoped, therefore, that anyone having ideas to contribute along this line will write directly to Doctor Popenoe who is a member of the Tropical Soils Committee of the Society.

[2] Specialist in Tropical Horticulture, United Fruit Company, Guatemala, C. A.

TABLE I.—Soil Separates.

	Columbia	Cuba	Puerto Rico
Fine gravel	Gravilla fina	Gravilla	Grava fina
Coarse sand	Arena gruesa	Arena gruesa	Arena gruesa
Medium sand	Arena media	Arena media	Arena media
Fine sand	Arena fina	Arena fina	Arena fina
Very fine sand	Arena muy fina	Arena muy fina	Arena finísima
Silt	Limo	Limo o polvo	Limo
Clay	Arcilla	Arcilla	Arcilla

TABLE II.—Soil Textures.

Sand	Arenoso	Arenoso	Arenoso
Loamy sand	Arenoso franco	Areno-franco	Arenosolómica
Sandy loam	Franco arenoso	Franco arenoso	Arenosolómica
Loam	Franco	Franco	Lómica
Silt loam	Franco limoso	Franco limoso	Limosolómica
Sandy clay loam	Franco-arcillo-arenoso	Franco-arcillo-arenoso	Areno-arcillosolómica
Clay loam	Franco-arcilloso	Franco-arcilloso	Arcillosolómica
Silty clay loam	Franco-arcillo-limoso	Franco-arcillo-limoso	Limoarcillosolómica
Sandy clay	Arcillo-arenoso	Arcillo-arenoso	Arenoarcillosa
Clay	Arcilloso	Arcilloso	Arcillosa
Silty clay	Arcillo-limoso	Acillo-limoso	Limoarcillosa

Note: Termination of above terms in *o* and *a* is a matter of gender and need not be taken into account.

Santos, Director of Agriculture at Habana, Cuba. These three gentlemen requested the heads of their soil departments to present their views regarding proper Spanish equivalents for the English terms, with the results tabulated on page 85.

Comparison of present usage in the three countries under consideration brings out the encouraging fact that differences are not so great as to prevent standardization if the desirability of achieving uniformity is generally admitted and accepted. In fact, the only real difficulty is with regard to the word "loam" for which there is no literal translation in Spanish.

In this connection we cannot do better than translate, in substance, the comments of Dr. Roberto Smith, Chief of the Laboratory of Agricultural Chemistry of the Ministry of Agriculture at Habana, who writes, in a memorandum dated 22 December 1941:

"Here, where we have adopted the methods of the Bureau of Soils at Washington, we have had to face a problem with regard to certain terms which have no simple, accurate equivalents in Spanish, and which, by force of circumstance, have had to be replaced by words natural to the Spanish language, or familiar to Cuban agriculturists.

"For example: The term 'loam' used in classifying soil textures is so difficult to translate into our language that we have had to eliminate it from our reports, since it would be understood only by technical men. In consequence, when we need to speak of loams in our publications we avoid this word and in its place show the proportions of *arena, limo y arcilla* (sand, silt and clay). Thus we say: *Suelo* (soil) *areno-limo-arcilloso; suelo areno-arcilloso-limoso; suello limo-arcilloso*, and so on. That is to say, the reader knows from the sequence of the terms the relative importance of sand, silt and clay in the soil under discussion.

"While we have attempted to find a suitable Spanish equivalent for the word 'loam' this has always resulted in arriving at a linguistic impasse. In view of this fact, we desire to suggest what seems to us a practical solution to the problem. In this country, it is a well-established custom to refer to loam soils as *tierras francas*. We therefore believe the term *franco* might well be adopted as the best Spanish counterpart of the English word loam."

Dr. Smith's suggestion is supported, very evidently, by usage in Colombia (as shown in Table II) but differs from that of Puerto Rico. The terms *lómica* and *solomica* employed in various combinations at Rio Piedras need clarification so far as the present writer is concerned; he has not met with them in other parts of Latin America nor is he able to find them in the *Diccionario Illustrado de la Real Academia Española.*

It is suggested that the present preliminary effort be followed by a more widespread solicitation of views, including those of workers in Mexico, Costa Rica, Venezuela, Ecuador, Peru, Chile and Argentina. There seem to be good indications that it will not be difficult to standardize Spanish equivalents of the English terms used in soil classification to a sufficient degree so that the publications of any given region will be readily intelligible to workers in any part of Latin America.

TERMINOLOGIA DE LA CLASIFICACION DE SUELOS EN EL IDIOMA ESPANOL [1, 2]

DR. WILSON POPENOE [3]

Entre las cosas que han progresado en la agricultura tropical, pocas han sido de tan favorables efectos y han tenido than enorme valor práctico como el uso de la clasificación de suelos. Basta citar como un ejemplo. la obra titulada "Suelos de Cuba", por Bennett y Allison, la cual es usada no solo por los técnicos sino tambien por los agricultores prácticos de toda la isla de Cuba.

En todas las repúblicas del trópico hace falta que se estudie y clasifiquen los suelos. y que se haga uso práctico de esas clasificaciones. Desafortunadamente. un trabajo de esta naturaleza requiere much energía y esfuerzo y no ofrece, para muchos investigadores, el atractivo de las investigaciones de laboratorio. El valor de estas clasificaciones, sin embargo, parece que empieza a reconocerse, extensamente y tenemos la esperanza de que el estudio y la clasificación de los suelos de muchas de las importantes zonas agrícolas del trópico se completará en nuestro tiempo.

Una de las dificultades con que tropiezan los que se dedican al estudio de los suelos, en los paises de habla española, es la falta de uniformidad existente en la equivalencia que, en español, se da a los términos ingleses usados en la clasificación de suelos.

En el estudio de los suelos en los trópicos, los investigadores latinoamericanos basan sus actividades en los trabajos establecidos por los ingleses y norte-americanos, y han adoptado la clasificación de textura de suelos usada en inglés, tratando, como es natural, de traducir la terminología inglesa al español. Pero al hacer esta traducción en varios paises, se ha dado diferentes nombres en español a la terminología inglesa, y esto hace que la interpretación de los resultados en una region sea difícil para los investigadores de otra región de la América tropical.

Consideramos que aun es prematuro establecer un código de la terminología en español que sea aceptado per todos los que se didican al estudio del suelo en los paises de habla española. Pero, entre mas pronto se principie a trabajar en pro de esta terminología, mas pronto se podrá establecer la uniformidad de la misma.

Colombia, Cuba y Puerto Rico son tres paises tropicales en los cuales la ciencia del suelo ha progresado un poco. Por este motive se ha con-

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[1] Este estudio fué preparado por el Doctor Popenoe, despues de las reuniones de la Sociedad en diciembre pasado, y tiene por objeto examinar la traducción al español de ciertos términos de uso corriente en la clasificación de suelos. Esto se está efectuando con el propósito de llegar a establecer una clase uniforme de equivalentes en español, en vista de la gran conveniencia que ello tendría en futuras discusiones de problemas de la ciencia de suelos en este ramo sobre una base bilingue. Se espera, por consiguiente, que cualquier persona que desee contribuir alguna idea en este sentido escriba directamente al Doctor Popenoe, quien es miembro del Comite de Suelos Tropicales de la Sociedad.

[2] Traducido por Mr. Joaquín O. Moncrieff, Guatemala.

[3] Especialista horticultura tropcal, United Fruit Company, Guatemala, C. A.

TABLE I.—SEPARADOS DE SUELOS.

	Columbia	*Cuba*	*Puerto Rico*
Fine gravel	Gravilla fina	Gravilla	Grava fina
Coarse sand	Arena gruesa	Arena gruesa	Arena gruesa
Medium sand	Arena media	Arena media	Arena media
Fine sand	Arena fina	Arena fina	Arena fina
Very fine sand	Arena muy fina	Arena muy fina	Arena finísima
Silt	Limo	Limo o polvo	Limo
Clay	Arcilla	Arcilla	Arcilla

TABLE II.—TEXTURAS DE SUELOS.

Sand	Arenoso	Arenoso	Arenoso
Loamy sand	Arenoso franco	Areno-franco	Arenosolómica
Sandy loam	Franco arenoso	Franco arenoso	Arenosolómica
Loam	Franco	Franco	Lómica
Silt loam	Franco limoso	Franco limoso	Limosolómica
Sandy clay loam	Franco-arcillo-arenoso	Franco-arcillo-arenoso	Areno-arcillosolómica
Clay loam	Franco-arcilloso	Franco-arcilloso	Arcillosolómica
Silty clay loam	Franco-arcillo-limoso	Franco-arcillo-limoso	Limoarcillosolómica
Sandy clay	Arcillo-arenoso	Arcillo-arenoso	Arenoarcillosa
Clay	Arcilloso	Arcilloso	Arcillosa
Silty clay	Arcillo-limoso	Acillo-limoso	Limoarcillosa

siderado que vale la pena comparar la terminología usada en estos tres países y emplearla como un ejemplo para ilustrar nuestro tema.

Una lista de los términos ingleses que se emplean para nombrar las diferentes partículas componentes del suelo y sus diferentes texturas fue sometida a las siguientes personas: Dr. J. A. B. Nolla, Director de la Estación Experimental Insular de Rio Piedras, P. R.; al Dr. Eduardo Mejia Vélez, Director de Agricultura, Bogotá, Colombia; y al Dr. José M. Santos, Director de Agricultura, Habana, Cuba. Estos tres señores pidieron a sus respecivos jefes del departamento de suelos, que presentaran su opinión en relacion con la propia equivalencia, en español, de los términos ingleses. Los resultados obtenidos aparecen en las Tablas I y II.

Comparando los términos usados en los tres países puede verse que las diferencias son muy pequeñas, lo cual es alentador, pues pone de manifiesto la posibilidad de establecer una terminología uniforme para todos los paises latino americanos. La única dificultad existe en la palabra "loam" para la que no hay traducción literal en español. Sobre este particular podemos mencionar los comentarios del Dr. Roberto Smith, jefe del laboratorio de química agrícola en la Secretaría de Agricultura de la Habana, Cuba, quién, en un memorandum fechado el 22 de diciembre de 1941, escribe:

"Aquí en donde se han adoptado los métodos del Departamento de Suelos de Washington, hemos tenido que afrontar un problema relacionado con ciertos términos ingleses que no tienen un equivalente simple y exacto en español los cuales, por la fuerza de las circumstancias, han tenido que reemplazarse por palabras propias de la lengua española o familiares a los agricultores cubanos. Por ejemplo, el término "loam" usado en la clasifición de textura de los suelos es tan dificil de ser traducido al español que hemos tenido que eliminarlo de nuestros reportes, ya que solamente los técnicos lo comprenderían. En consecuencia, cuando tenemos que hacer referencia de "loam" en nuestras publicaciones, evitamos el uso de esta palabra y ponemos en su lugar las cantidades de arena, limo y arcilla. Asi, nosotros decimos: Suelo areno-limo-arcilloso; suelo areno-arcilloso-limoso; suelo limo-arcilloso; etc. Es decir, que el lector conoce por la secuencia de los términos la importancia relativa de la arena, el limo y la arcilla en la tierra que se toma en consideración."

"Cuando hemos intentado buscar una palabra en español que sirva como equivalente de la palabra inglesa "loam", hemos terminado encontrandonos en un atolladero lingüistico. En vista de esto, deseamos sugerir algo que parece ser una solución práctica del problema: en este pais es una costumbre ya bien establecida el llamar "tierra franca" a lo que en inglés se llama "loam soils", por consiguiente, creemos que el término "franco" puede muy bien ser adaptado como el mejor equivalente a la palabra inglesa "loam"."

La sugerencia del Dr. Smith tiene en su favor el uso de la palabra "franco" en Colombia, como puede verse en la Table II, pero difiere de la terminología de Puerto Rico. La opinión del que escribe es que los terminos "lómico" y "solómico" usados en varias combinaciones en Rio Piedras, P. R., necesitan ser aclarados. El que escribe no ha encontrado

estos términos en ninguno de los otros paises de la América Latina, y tampoco en el Diccionario Ilustrado de la Real Academia Española.

Es de sugerirse que el presente esfuerzo preliminar sea seguido por una amplia solicitud de puntos de vista, incluyendo a los investigadores, de México, Guatemala, Costa Rica, Venezuela, Ecuador, Perú, Chile y Argentina. Parece que hay buenas indicaciones de que no será muy difícil establecer un sistema uniforme de términos en español equivalente a los términos ingleses usados en la clasificación de suelos, a efecto de que las publicaciones de cualquier región puedan entenderse en cualquier parte de la América Latina.

SYMPOSIUM: METHODS OF SOIL INVESTIGATION
Florida Union, Friday, December 5, 1941
1:30 P. M.

DETERMINING ORGANIC MATTER IN FLORIDA SOILS

R. Stanley Dyal, Jr. and Matthew Drosdoff [1]

Loss on ignition has been used extensively (2, 5, 6, 8, 11) as a measure of organic matter contained in the sandy soils of Florida. It was reported in 1932 by Stokes, et al. (11) as a satisfactory method for this purpose. Heyward and Barnette (6) used loss on ignition as an estimate of the organic matter of some soils of Florida, South Carolina, Georgia, Alabama and Mississippi. In determining organic matter in some tung orchard soils, however, the authors felt that the loss on ignition method would not be suitable because of the higher clay content of some of the soils. The chromic acid oxidation method which has been employed successfully by other workers (1, 3, 10, 12, 13) was used and found satisfactory. It proved to be a simple, rapid and fairly accurate method. It was thought, therefore, that it would be of interest to report some data obtained by this method as compared to the loss on ignition.

The loss on ignition was determined by igniting a 10 gm. sample of soil in an electric furnace for one hour at 700 degree C. The ignited residue was examined to make certain that all the organic matter had been oxidized. The chromic acid oxidation method used was a modification of Walkley's procedure as follows:

A weighed quantity of soil passing a 40 mesh sieve, not exceeding 10 gms. and containing from 10 to 25 mgms. of carbon, is placed in a 500 ml. Erleymeyer flask. For a soil containing about 2 percent organic matter, a 2 gm. sample will give a convenient titration. Ten mls. of normal potassium dichromate solution are added from a burette followed by 20 mls. of concentrated sulphuric acid (not less than 96 per cent). The mixture is shaken for one minute and left to stand on a sheet of asbestos or other convenient heat-resisting material for 30 minutes. Then 200 mls. of water are added, followed by about 10 mls. of concentrated (85 per cent) phosphoric acid and five drops of .025M orthophenanthroline ferrous complex indicator (9). This solution is then titrated with a normal ferrous sulfate solution in N/2 sulphuric acid until the solution turns from the orange color of the dichromate ion to a light green and finally at the endpoint the solution flashes pink upon the addition of one drop. If more than 8 mls. of the 10 mls. of potassium dichromate are used up, the determination is repeated using less soil rather than more dichromate. If more than 10 mls. dichromate are used the endpoint in the titration is less distinct. Walkley found mean recoveries of

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about 77 per cent making necessary a correction factor of 1.3. Therefore 1 ml. of normal potassium dichromate solution is equivalent to 1.3x3.0 or 3.9 mgm. of carbon. To convert to organic matter multiply this by the conventional factor of 1.724. Thus 1 ml. of normal dichromate is equivalent to 6.72 mgms. of organic matter. The ferrous sulfate should be stored in a dark bottle under hydrogen (a piece of aluminum wire dropped in the solution may suffice), or with a thin film of white mineral oil over it to prevent oxidation. Determinations were made on a number of Florida soils and the results are given in Table 1 in comparison with loss on ignition and with the standard dry combustion method. The clay content, as determined by the hydrometer method (4), is included in the table. The data given are averages of duplicate determinations which usually were in very good agreement.

In general all three methods compare favorably on most of the very sandy soils, that is, those containing a relatively small percent of clay. As would be expected, the greatest discrepancy between the loss on ignition and the other two methods was found to be with soils having the higher clay content. An extreme example is shown in the case of the Red Bay fine sandy loam (I) 0″-7″ containing over 11 percent of clay. The organic matter content as determined by the loss on ignition method was 3.7 percent as compared to 1.17 and 1.2 by the dry combustion and chromic acid oxidation respectively. This large difference was undoubtedly due to the water of combination in the clay which was lost on ignition and therefore included with organic matter. Knowing the clay content one can roughly estimate the combined water present, and the extent of error in using loss on ignition for organic matter. The predominant clay mineral in the soils of Florida is probably of the Kaolinite type with a formula approximating $Al_2O_3 \cdot 2\,SiO_2 \cdot 2\,H_2O$. There is about 14 percent of combined water in this clay mineral. Theoretically, therefore, a soil with 10 percent clay would have 1.4 percent of combined water and one with only 5 percent of clay would have 0.7 percent. Therefore, it was not surprising to find the loss on ignition values much too high in the soils with more than 5 percent of clay.

This explains some of the results of Heyward and Barnette (6) who found eleven soils out of thirty-four having a greater loss on ignition in the sub-soil than in the subsurface. The lower layers of some of these soils undoubtedly contained more clay and consequently more combined water so that the loss on ignition data could not possibly be used as a measure of the organic matter in these soils. For example, Norfolk fine sandy loam with a yellow subsoil was reported to have 4.110 percent loss on ignition at from 10 to 12 inches and 2.388 percent loss at from 6 to 8 inches. Also Norfolk fine sand had for the same depths as the Norfolk fine sandy loams 2.435 and 1.649 percent loss on ignition. Two samples of Orangeburg fine sandy loam with a red friable subsoil were reported to have a higher percentage of loss on ignition in the lower layers than in the intermediate layers. This clearly indicates the large error involved in using loss on ignition as an estimate of organic matter in these soils. Holmes, et al. (7) reported the organic matter content as determined by dry combustion on some of the same soil types and found less than one percent organic matter in the lower layers whereas loss on ignition was as high as 8 percent.

TABLE 1.—ORGANIC MATTER CONTENT OF SOME FLORIDA SOILS AS DETERMINED BY CHROMIC ACID OXIDATION, DRY COMBUSTION AND LOSS ON IGNITION, AND CLAY CONTENT.

Soil Type	Depth	Organic matter by			Clay < 0.005mm
		Dry Combustion [1]	Chromic Acid Oxidation	Loss on Ignition	
	inches	percent	percent	percent	percent
Norfolk fine sand I	0-6	1.49	1.4	1.8	3.6
Norfolk fine sand II	0-3	0.93	1.0	1.2	1.6
Norfolk fine sand III	0-6	1.03	1.1	1.9	4.1
Orlando fine sand	0-6	3.88	4.0	4.4	4.6
"Inverness" fine sand	0-7	1.73	1.8	3.7	5.2
Arredonda loamy fine sand I	0-6	3.12	3.1	3.5	7.8
Arredonda loamy fine sand I	6-12	1.45	1.4	2.3	9.8
Red Bay fine sandy loam I	0-7	1.17	1.2	3.7	11.44
Leon fine sand	0-1½	15.87	16.3	16.9	4.6
Leon fine sand	1½-3	3.17	4.1	3.2	2.6
Leon fine sand	3-8	......	0.3	0.3	1.8
Leon fine sand	8-11	3.56	4.6	3.6	3.1
Norfolk fine sand III	6-12	......	1.0	1.8	4.8
Norfolk fine sand IV	0-6	......	0.8	1.2	2.2
Blanton sand	0-7	......	1.0	1.1	3.3
Blanton sand	7-26	......	0.6	0.9	2.3
Blanton sand	26-36	......	0.3	0.4	1.6
Fellowship loamy sand	0-6	......	1.7	1.8	3.6
Fellowship loamy sand	6-18	......	0.5	1.3	8.3
Gainesville fine sandy loam	0-6	......	1.2	1.6	5.4
Gainesville fine sandy loam	6-12	......	0.5	0.9	4.6
Ruston fine sandy loam	0-6	......	1.3	2.2	7.9
Ruston fine sandy loam	6-16	......	0.3	2.0	11.9
Arredonda loamy fine sand II	0-6	......	3.6	4.5	5.6
Arredonda loamy fine sand II	6-12	......	1.6	2.7	6.6
Arredonda loamy fine sand III	0-6	......	3.0	4.4	7.9
Arredonda loamy fine sand III	6-27	......	2.2	3.6	8.4
Arredonda loamy fine sand III	27-46	......	0.8	......	......
Arredonda fine sandy loam I	0-6	......	2.5	......	......
Arredonda fine sandy loam I	6-9	......	1.4	......	......
Arredonda fine sandy loam I	9-12	......	0.9	......	......
Arredonda fine sandy loam I	15-18	......	0.6	......	......
Arredonda fine sandy loam I	21-24	......	0.6	......	......
Arredonda fine sandy loam II	0-6	......	5.1	......	......
Arredonda fine sandy loam II	6-9	......	2.4	......	......
Arredonda fine sandy loam II	9-12	......	1.6	......	......
Arredonda fine sandy loam II	15-18	......	0.9	......	......
Arredonda fine sandy loam II	21-24	......	0.5	......	......
Red Bay fine sandy loam II	0-6	......	2.5	......	......
Red Bay fine sandy loam II	6-9	......	1.2	......	......
Red Bay fine sandy loam II	9-12	......	0.9	......	......
Red Bay fine sandy loam II	15-18	......	0.5	......	......
Red Bay fine sandy loam II	21-24	......	0.4	......	......
Red Bay fine sandy loam III	0-6	......	1.9	......	......
Red Bay fine sandy loam III	6-9	......	1.1	......	......
Red Bay fine sandy loam III	9-12	......	0.8	......	......
Red Bay fine sandy loam III	15-18	......	0.7	......	......
Red Bay fine sandy loam III	21-24	......	0.4	......	......
Red Bay fine sandy loam, eroded phase	0-3	......	1.7	......	......

Red Bay fine sandy loam, eroded phase	3-13	......	0.7	......	......
Red Bay fine sandy loam, eroded phase	13+	......	0.4	......	......
Norfolk fine sandy loam, deep phase	0-9	......	0.9	......	......
Norfolk fine sandy loam, deep phase	26-40	......	0.2	......	......
Norfolk fine sandy loam, deep phase	40+	......	0.1	......	......

[1] Thanks are due the Division of Soil Chemistry and Physics, Bureau of Plant Industry for these determinations which were made in their laboratory by the standard dry combustion method.

Peech (8), using the loss on ignition method, reported a Parkwood sandy loam as having almost twice as much organic matter in the 18 to 24 inch layer as in the surface 6 inches, but the description of this soil in the text indicates that there is more organic matter in the surface soil than in the lower layers. The 18-24 inch layer is described as a yellowish clay and the loss on ignition value, therefore, is probably largely due to the combined water of the clay rather than to organic matter.

It should be pointed out that even on soils classified as sands there may be up to 10 percent silt and clay and usually the content of clay is higher than that of silt in the sandy soils. A sand with 7 percent clay would have about one percent combined water. Therefore if loss on ignition was 2 percent, the organic matter content would actually be about one percent. In this case the error in using loss on ignition as an estimate of organic matter would be 100 percent. The presence of carbonate is also a source of error in using loss on ignition as an estimate of organic matter. It is often overlooked, and even when noted, it is difficult to make a correction.

It will be noted in Table 1 that the organic matter content of the lower horizons of the Leon fine sand is higher as determined by the chromic acid method than by either the loss on ignition or dry combustion methods. Apparently the organic matter in the lower layers of this soil is very finely divided, and from observations of the residue, is apparently completely oxidized by the chromic acid. Consequently the use of the factor 1.3 gives results that are too high. If no factor is used in this case the methods agree very favorably. Browning (3) found with a wide variety of soils that a factor of 1.18 gave results in good accord with dry combustion data. He did not, however, use any soils of the Coastal Plain. More recently, Smith and Weldon (10) using the Walkley method found an average recovery of 74 percent compared with wet combustion which gives a factor of 1.35. They also did not report on any soils of the Coastal Plain. Disregarding the Leon subsoils which give a recovery of almost 100 percent, the average recovery of the other nine samples here reported, for which combustion data were available, was 78.5 percent which gives a factor of almost 1.3. With most of the surface soils of the Southeast the factor of 1.3 would probably be satisfactory as is indicated by the excellent agreement between the chromic acid method with this factor and the dry combustion method in the case of those soils for which

data from both methods are available. With soils having an apparently different type of organic matter, as the subsoil of the Leon fine sand, a different factor would probably have to be used. It has been suggested (10, 12) that the chromic acid oxidation is a measure of the active organic matter or humus in the soil and the values obtained be used directly without resorting to an empirical factor. It seems to the authors that there is some merit in this idea as it is the relative values of the active organic matter which are of primary interest in most soil studies.

The chromic acid oxidation procedure is even more rapid than loss on ignition as only one weighing is necessary, whereas two are needed for the latter. The titration is rapid and the end point with orthophenanthroline ferrous complex as an indicator is very distinct and gives a warning color change before the end point is reached, thus practically eliminating the need for a back titration.

The chromic acid oxidation requires inexpensive chemicals and equipment and a large number of samples can be run in a relatively short time.

Summary

Organic matter as determined by a modification of Walkley's chromic acid oxidation procedure was compared with determinations by the loss on ignition and dry combustion methods. The results agreed closely for most soils where there was a relatively small percentage of clay, but with soils of higher clay content, due to the combined water present, the loss on ignition method gave values too high. The chromic acid oxidation procedure is recommended for Florida soils as a simple, rapid, inexpensive, and fairly accurate method. The large source of error due to combined water makes the loss on ignition method unsuited for estimating organic matter on Florida soils, even on some soils classified as sand.

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ADSORPTION AND FIXATION OF COPPER IN SOME SANDY SOILS OF CENTRAL FLORIDA

VERNON C. JAMISON[1]

ABSTRACT[2]

The adaptation to the study of sandy soils of Florida of the method of Sieling (Jour. Amer. Soc. Agron. 33:24-36, 1941) for the determination of soil exchange capacity was checked. As compared with the ammonium acetate method, extremely variable and generally low results were obtained.

A study of copper adsorption by four central Florida sandy soils was made. Samples of soil were suspended in copper acetate solutions of increasing concentrations all buffered at pH 4.6 with acetic acid. After shaking periodically for several hours and allowing to settle over night, the supernatant solutions were filtered and the copper determined quantitatively. Three of the soils adsorbed increasing quantities of copper as the concentration increased. The amounts of copper adsorbed by two samples of Norfolk fine sand, in m.e. per 100 grams, at the highest concentration used (0.49 N) were about three times the respective exchange capacities as determined by the ammonium acetate method. With all four soils the adsorption of 0.2 N Cu^{++} was in the same order of magnitude as the soil exchange capacities.

Since Peech (Soil Sci. 51:473-486, 1941) found that only a small portion of the copper added as sulfate to an acid Norfolk fine sand was recovered by a single salt extraction, the question arose as to what quantities would be removed by additional extraction. Also, whether the capacity of Norfolk and other sandy citrus soils for "fixing" copper was limited to relatively small amounts in comparison with their exchange capacities.

Three sets of samples each of six soil types were leached with 100 ml. portions of 0.2 N $Cu(C_2H_3O_2)_2$ (copper acetate) and washed with 80 percent alcohol to remove the excess salt. One set was leached continuously with 1.7 N NaCl (sodium chloride), another set with 1.7 N $BaCl_2$ (barium chloride) and the third set with N HCl (hydrochloric acid). The salt extractants were adjusted to pH 4.6 with acetic acid. The leachates were caught in 100 ml. portions and analyzed for copper content. Copper was removed continuously by the salt solutions from each of the soils in appreciable amounts even after the tenth portion had been leached. NaCl was found to be more effective than $BaCl_2$, and though HCl was most effective, two 100 ml. portions removed less copper in all cases than ten 100 ml. portions of NaCl.

In other similar experiments with Eustis fine sand N $NaC_2H_3O_2$ (sodium acetate) was found much more effective than 1.7 N NaCl; N/10 no more effective than N NaCHO (sodium acetate) in copper removal $HC_2H_3O_2$ (acetic acid) was much less effective than N $HC_2H_3O_2$ and

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[2] Complete paper published in Soil Science, Vol. 53, No. 4, pp. 287-297, 1942.

no more effective than N $NaC_2H_3O_2$ (sodium acetate) in copper removal from copper-treated soil.

It appears that not only is solution and replacement action important in mobilizing copper that is fixed in the soil but the dispersion of the organic matter to which it may be fixed is of significance as well. This is evident from the greater effectiveness of NaCl over $BaCl_2$. It may be that appreciable quantities of copper are leached from the soil as dispersed humates. The question remains as to whether this form of copper can be adsorbed by citrus roots.

FACTORS INFLUENCING THE TURBIDIMETRIC DETERMINATION OF POTASH

G. M. Volk[1]

There has long been a need for a more rapid method of estimation of available potassium in the soil. In answer to this, numerous versions of turbidimetric methods of estimation have been suggested. The principle of all such methods is the precipitation of potassium as the sodium-potassium cobaltinitrite salt. This precipitate is variable in composition, depending upon the conditions under which its formation takes place. The use of an alcohol for concentration and a high content of sodium in the solution increase the sensitivity of the precipitation to the point where quantities of potassium found in acid or salt extracts may be detected. The method thus lends itself to the direct estimation of potassium in soil extracts without going through the tedious concentration purification procedures essential in gravimetric, colorimetric or titrimetric methods.

The estimation of potassium by observation of the amount of turbidity produced, enhances sources of error which are relatively unimportant or easy to overcome when other types of procedures are used. Those methods which depend upon quantitative precipitation for filtration are not affected by the size of the precipitated crystals as long as the crystals are filterable and fairly constant in composition. Where factors such as temperature changes, reagent concentrations, speed of mixing, time of standing and impurities in the extracts change the particle size, a serious error in turbidimetric estimation appears.

Other sources of error which must be taken into consideration when determining potassium directly in a soil extract are the quantity of ammonia present, interferences by concentration of salts by the alcohol, and the effect of the organic matter on the speed and completeness of formation of the turbidity.

The turbidimetric determination of potassium was studied with respect to its adaptation for use on carbonic acid extracts of Florida soils. To be practicable, the method should be sensitive to 5 PPM of potassium in solution and have a range up to approximately 30 PPM without dilution. A sensitive, stable precipitating reagent consisting of 17 grams of sodium cobaltinitrite and 40 grams of sodium acetate made up to 100 ml. with water was selected. This reagent did not decrease in sensitivity over a four months period when stored in a stoppered bottle at approximately 4° C. After considerable preliminary investigation the following method was devised for further checking.

Eight milliliters of soil extract or synthetic equivalent containing 0.2 per cent acetic acid were pipetted into a 150 ml. beaker, 2.5 ml. of formaldehyde and 2 ml. of precipitating reagent added and the beaker placed on a motor agitator carrying a four-paddle glass stirrer.[2] The motor was

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[2] Replacement of hand shaking by motor stirring was first suggested and used in Florida by R. A. Carrigan, Assistant Chemist, Florida Agricultural Experiment Station.

started simultaneously with the opening of an automatic pipette delivering 50 ml. of 95 per cent ethyl alcohol into the center of the beaker in approximately 60 seconds. Stirring was continued for two minutes from the time of starting the motor. The suspension was immediately transferred to a 2.5 cm. horizontal cell and read with a photoelectric colorimeter two minutes after it was removed from the stirrer.

The reading was made in per cent transmission against a standard curve calibrated from known solutions. To eliminate the warming up effect of the light beam and the cell carriage, the suspension was not placed in the instrument for reading until it was time for the measurement. It was also found necessary to run samples at exact intervals to prevent variable errors resulting from the warming up and cooling of the apparatus.

It was immediately apparent from preliminary tests that temperature variation brought about a big variation in the amount of turbidity produced from any given amount of potassium. A temperature variation of as little as three degrees was sufficient to change the apparent amount of potassium as much as fifty per cent when low quantities of the element were present, while with larger quantities such changes caused an error of thirty per cent or more. It was impossible to calibrate the changes in temperature against the apparent quantity of potassium present as was at first attempted, therefore it was thought that some other factor such as a relative humidity, which might have an effect on the rate of cooling of the suspension while being stirred, was affecting the intensity of the turbidity. However, it was possible to obtain quite reproducible results over a period of approximately two hours time if not over 0.5° C. difference in temperatures of suspensions after stirring was apparent. A method in which calibration determinations were made with standards every two hours was devised and proved quite satisfactory with pure potassium chloride standards. A check of the effect of time of stirring gave a surprisingly low variation of only three per cent transmission or equivalent to approximately one part per million of potassium where one minute of stirring was compared to four minutes. The time of standing after stirring likewise gave a very small variable of approximately four per cent transmission difference between two and five minutes of standing. It appeared that the previously outlined method had possibilities for rough estimation of potassium in solution provided that other factors such as organic matter, ammonia and salts in the soil extracts did not interfere or could be eliminated.

High calcium salts were thought to be the greatest possible source of salt interferences in Florida, especially on the marl-bearing soils of the peninsular sections of the state. Up to 4000 PPM of calcium, either as the chloride or acetate, did not interfere with the accuracy of the estimation of potassium in standard solutions. This is considerably above any amount of such salts to be found normally in Florida soils.

Interference by ammonia is a real possibility, especially where fertilizers of certain types have been used. Ammonia precipitates the same as does potassium in the presence of the reagents used in this method. Ammonia and formaldehyde react together to form hexamethylenetetramine, a compound in which the ammonia is no longer subject to

ionization and precipitation by the reagents used in the method. One ml. of formaldehyde was found to be sufficient to prevent interference of 100 PPM of ammonia when no potassium was present. When 10 PPM of potassium was present, however, each 6 PPM of ammonia made a cumulative error equal to approximately 1 PPM of potassium, and the presence of 60 PPM made an error of plus 100 per cent. Increasing the amount of formaldehyde decreased the interference by ammonia until it completely disappeared with the addition of 2.5 ml. to the 8 ml. of standard potassium solution containing 50 PPM of ammonia.

The first attempts to apply the procedure to soil extracts indicated that there was considerable interference from high quantities of soluble organic matter. The organic matter evidently retarded the precipitation by releasing the potassium slowly so that large crystals formed instead of the fine crystals resulting when rapid precipitation took place. An extract of peat carrying .179 per cent of organic matter having an absorption of 11 per cent per centimeter without a filter was added to standard potassium solutions and the error resulting in turbidimetric determination of the potassium calculated, taking into consideration the potassium content of the peat extract. A solution made up to contain .157 per cent organic matter reduced the turbidity by approximately fifty per cent. Interference disappeared at about .011 per cent organic matter. This solution had an absorption of approximately 0.5 per cent per centimeter. From this value it appeared that extracts from most mineral soils could be read without dilution without interference by organic matter. Further checking by means of dilution of extracts and additions of potassium did not substantiate this conclusion. It was quite evident that organic matter in the extract interfered to a marked extent. This phase of the study must be continued to determine, if possible, the effect of different kinds of soluble organic matter and possible methods for its destruction or removal. Extractants other than carbonic acid may give extracts sufficiently low in organic matter to eliminate this interference. However, the writer is of the opinion that all existing or suggested methods for the turbidimetric estimation of potassium in soil extracts should be carefully checked to evaluate this possible error before being put into use under Florida conditions.

INSTALLATION OF LYSIMETERS IN THE PEAT SOIL OF THE FLORIDA EVERGLADES

J. R. NELLER AND W. T. FORSEE, JR.[1]

Although lysimeter studies are under way with mineral soils in various regions they have not been reported as having been undertaken with organic soils. There are probably two main reasons for this, one being that the area of organic soils given over to cultivation has been comparatively small and the other that the presence of a water table near the surface makes the conventional lysimeter design impracticable. In the present instance provision for the collection of leachate and for subsurface irrigation was made by installing the lysimeters in a soil-filled structure above ground level. This box is four feet high, nine feet wide and 18 feet long. Along both sides of it a shed 32 inches wide (Fig. 1) was constructed to house the containers and irrigation system.

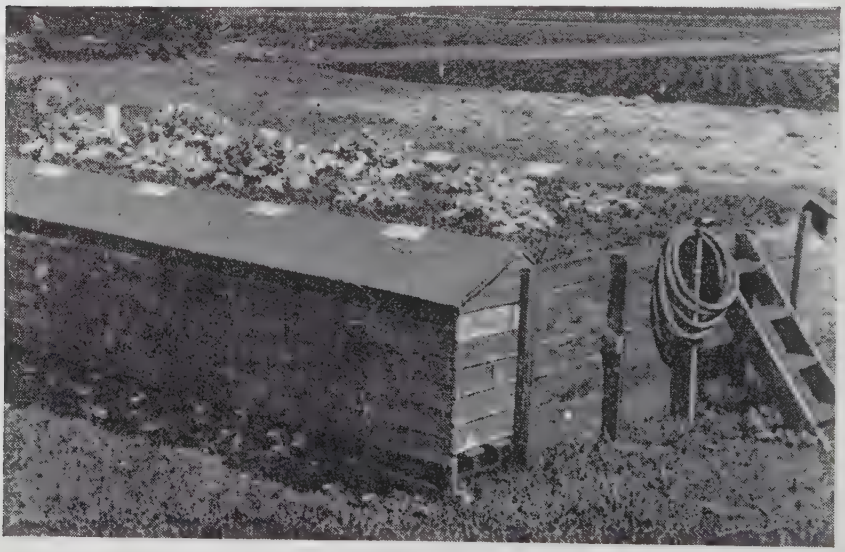

Figure 1.—General view of a 10 unit lysimeter which provides for study of a cropped organic soil with a high water table.

The lysimeters consist of 20-gallon, glazed jars with perforated, conical bottoms, which were installed in the box on 2 x 6 pitch-pine stringers. The ends of these stringers extend through the walls of the box and are spiked to the 2 x 4 uprights, these being outside the walls of the box. Before the structure was filled with soil all of the wood surfaces were well creosoted. Ten of the 20 gallon jars were thus installed with a minimum distance of 24 inches between jars and outside walls and of 24 inches from jar to jar in a crosswise and 18 inches in a lengthwise

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direction. Peat soil was well packed below and around the lysimeters and the surface was planted to St. Augustine grass. During the two years that the lysimeters have been in operation, the growth of this grass has been similar to that of the grass growing in the surrounding field in which the lysimeters are located. The temperature of the soil in the open field in which the lysimeters are located has been found to be similar to that in the soil of the lysimeter box which indicates that the jars are sufficiently insulated by the surrounding soil.

The outlet of the conical bottom of the lysimeter jar is fitted with a rubber stopper in which the ½-inch (inside diameter) block tin tubing is inserted for the conduction of the leachate and of the irrigation water. The rubber stopper and the perforated porcelain plate is encased in asphalt. The bottom of the jar is set 24 inches above the bottom of the lysimeter box which is high enough to permit the block tin tube to have a slope amounting to a four inch drop to the outer wall of the box, (A, Fig. 2).

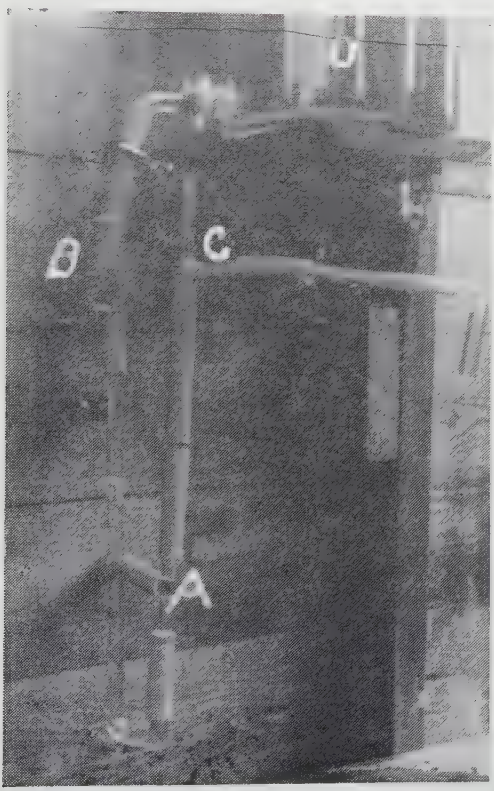

Figure 2.—Detail of a combined subirrigation and leachate collecting unit. Leachate flows out of drainage tube A and up to level B which is the designated water level in the lysimeter. Soil water rising above B flows out tube C to the collecting vessel. When the soil water level falls below B, irrigation water flows into lysimeter from D.

To provide for the requirement that the water level in the lysimeters should be maintained by either removing or adding water, the arrangement shown in Fig. 2 is used. This consists of a glass U-tube with rubber tubing connection to the block tin tube (A) whereby water enters the bottle (D) when the level falls in cup (B), this being the controlled soil-water level in the lysimeter. When, on the other hand, the soil water level gets too high because of rainfall the excess flows out through tube (C) into the leachate receiver. Outlet (C) is an inch higher than water level (B) thereby preventing irrigation water from (D) flowing out through (C). The collecting vessels that were first used were eight gallon straight walled jars. Although these were provided with covers they were not tight enough to keep insects out of the leachate. As a consequence five gallon bottles are now being used and the inlet

tubes are inserted into the mouths of the bottles in cotton plugs. The galvanized squares in the roof of the enclosure (Fig. 1) are removed to permit filling the bottles with water.

OPERATION OF THE LYSIMETERS

For the present, a study is being made of one soil type only, this being the Everglades peat (sawgrass origin) that covers most of the Everglades area. In November, 1939, a quantity of this soil was obtained from a field that had been plowed for the first time in 1934. Since the area had been under water control for several years previous to as well as the five years following plowing, the surface soil had lost much of its fibrous nature. In 1934 and 1935 the field had grown crops of forage cane for which an application of 200 pounds of sulfate of potash per acre was used. Copper sulfate, at the rate of 50 pounds per acre was also added, as it had been previously found by Allison, et al., (1) that virgin sawgrass peat lands definitely require copper to bring them into production.

The top eight inches of this peat was much less fibrous than that below and it was removed and kept separate from the next ten inches. These depths were selected as the 20-gallon lysimeters provide for a total soil depth of 18 inches. The conical bottom of each jar was filled with acid treated and washed sand. This sand was put through a 16-mesh sieve and the particles that did not pass were placed over the perforated porcelain disk upon which the finer fraction was spread. Soil from the lower 10 inches of the layer was transported to the lysimeters without sieving or breaking up the fibrous mass except as was necessitated in handling it with a shovel. After this layer had been tamped into place the screened material of the surface soil was used to fill the jar to the prescribed depth. The amounts of soil each lysimeter received as well as its pH and moisture content were as follows:

Field and Lysimeter Depth (Inches)	Reaction (pH)	Per Lysimeter		
			Oven-dry Basis	
		Moist Soil (Lbs.)	Moisture (Percent)	Soil (Lbs.)
0-8	5.3	59.4	65.94	20.23
9-18	5.5	79.2	81.06	15.00

The side walls of the lysimeter box were marked at B (Fig. 2) to correspond to a water level 17 inches below the soil surface in the lysimeter jars. The water level can be changed by shifting the elevation of the water in Cup B. The lysimeters were filled with soil to within two inches of their tops so that the rainfall which often occurs in brief, heavy downfalls in this region, would have time to penetrate into the soil. As previously mentioned, there is little runoff from this organic soil, at least in the early stages of its development.

During the dry season, which normally extends from October to June, much of the water needed by the lysimeter enters from Bottle D

(Fig. 2). This method of subirrigation is necessary in order to place the soil in the lysimeter jars under as nearly natural conditions as possible. The three-gallon Woulf Bottle, D, is filled through the small holes showing in the roof of the structure (Fig. 1). On sunny days it is necessary to have Bottle D full or nearly so each morning otherwise the heating and expansion of the air in the upper part of the bottle forces water over into the leachate container.

In as much as the soil in the lysimeters is not lying upon the deeper layers of peat which in turn lie upon the marl it is necessary to use soil water for the subirrigation of the lysimeter. Based upon information previously obtained (3) relative to soil waters, this irrigation water is taken from a shallow well, the collecting reservoir of which is about two feet above the marl substrata. Should the lysimeter soil become too alkaline as shown by periodical pH measurements the irrigation water will be obtained for a time from the Hillsboro drainage and irrigation canal. This water contains less lime and the use of it causes sawgrass peat to become more acid in reaction.

During the rainy season, which normally extends from June to October, natural sources supply most of the water that the lysimeters need with periodical excesses leaching out through the collecting systems. Most of the rainfall passes down into the soil for the reason that although the rains are generally intense they do not as a rule continue very long at a time. There are very few rains of two inches or more (2). The average annual precipitation is 57.71 inches, most of which occurs during June to September, inclusive.

There is, accordingly, a considerable amount of leachate from these lysimeters and it is being analyzed for the various plant food elements. These data are being correlated with the analyses of crops removed and and of plant foods added as fertilizer. As described above, the lysimeters and the leachate collecting systems are constructed of materials that do not release any traces of the elements copper and manganese and only inappreciable amounts, if any, of zinc and boron. Consequently it is possible to include the occurrence and behavior of these elements in these studies.

Some of the more important crops of the region, such as celery and pasture grasses, are being grown in these lysimeters. It was feasible, therefore, to include a comparative study of different kinds and amounts of fertilizer treatments of which there are five variations in the experiments now under way.

From a determination of plant food lost to the percolate, information is being obtained relative to losses by leaching under different fertilizer practices. Summation of plant food leached with that removed in crop growth from the lysimeters leaves a residue of plant food which was in an available form when added, but which is retained or made non-available by the soil.

SUMMARY

The conventional type of lysimeter with underground outlets is not feasible for a study of arable organic soils for the reason that the water table must be held fairly near the surface in order to have good growing

conditions as well as to conserve the soil. Accordingly, the lysimeters described in this paper were installed above the surrounding soil surface in a structure that is filled with the organic soil. Field conditions are thereby maintained except that the soil surface in the lysimeter is four feet above that of the adjacent land.

Details of the installation are given, including a subirrigation device which provides the type of subirrigation at controlled water table levels practiced in cultivated lands of the Everglades.

In the present study these lysimeters contain one type of soil only, this being Everglades (sawgrass) peat, typical of most of the Everglades area. Vegetable and grass crops are being grown at different fertilizer levels in these studies and information is being obtained concerning the utilization and availability of added plant food elements, both primary and secondary.

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SYMPOSIUM: PASTURE FERTILIZATION IN FLORIDA
College of Agriculture, Saturday, December 6, 1941
9:00 A. M.

SELECTING SOILS FOR PASTURES IN FLORIDA

J. R. HENDERSON [1]

There are more than twenty different plants which have been found suitable for use in Florida pastures under various conditions and there are more than one hundred soil types within the State from which to select for use in pasture development. Naturally, there is a great variation in the requirements of the different plants and in the ability of the various soils to meet these requirements. Broadly speaking, the suitability of any one of the various soil types for the production of a given pasture plant depends upon the ability of that soil to meet the nutrient and moisture requirements of the plant and upon the temperature conditions in the area where the soil occurs.

Comparatively few of Florida's soils are capable of meeting fully the requirements of pasture plants without some form of fertilization. However, the different soils afford a wide variety of conditions as regards the supply and availability of plant nutrients. Some are well supplied with calcium, others with nitrogen, and still others with phosphorus. On the other hand, some soils are poorly supplied with nutrients, others have low capacities for the retention of added nutrients and still others have a remarkable capacity for changing certain nutrients to forms in which they are largely unavailable to most plants. This important subject will be discussed more fully in the papers that follow which are based on research with several kinds of pasture plants on some of the more important soils in the State. In passing, it should be said that the ability of soils to retain certain plant nutrients such as calcium, magnesium and potassium in an available form is closely associated with their moisture holding capacity and is controlled by about the same factors that determine this value for an individual soil.

The moisture conditions within a given soil are determined largely by (A) the texture and organic content of the surface soil [2] (B) the depth and texture of the clayey subsoil (lower subsoil or B horizon) and (C) the depth to the water table.

The textures of the surface layers of Florida soils range from light sands to fairly heavy clays. However, most Florida soils have light textured surfaces, the most important textures in the order named being sands, loamy sands and sandy loams. Of these, the sands have the

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[2] As used here, surface soil refers to the A-1 horizon or that part of the topsoil which has been enriched by organic matter and the true or lower subsoil to the B horizon or that part which has been enriched by materials that have moved downward from the surface soil. In our deeper, sandy soils the upper subsoil is that section of the profile lying between the dark topsoil and the lower or clayey subsoil.

lowest water holding capacity and the sandy loams the highest. The moisture holding capacity of a soil of given texture is greatly increased if organic matter is present.

The depth and texture of the subsoil has much control over the moisture conditions within a soil. If the subsoil is of heavy texture and comparatively near the surface, the soil has a high moisture holding capacity. On the other hand, if the subsoil is of light texture or occurs at considerable depth the soil has a low moisture holding capacity. The subsoil acts as a storehouse for moisture and, in the manner of a lamp wick, pumps the water upward to the surface layers of the soil where it is used by the plants. The lighter the texture, the smaller the distance through which water may be moved in this manner. Thus shallow rooted plants growing on deep sandy soils may suffer from a shortage of moisture unless the water table is near the surface.

Since many Florida soils are quite sandy in texture and contain very little organic matter, the depth of the water table becomes very important especially in the production of plants which require an abundant supply of moisture. For instance, Plummer fine sand, which has a high water table, is highly satisfactory for the production of White Dutch clover while Norfolk fine sand, which has a very low water table, will not grow this plant at all. On the other hand, the water table of some soils is too high for the production of most pasture plants.[3]

As already stated there are more than twenty plants which have been found suitable for use in Florida pastures. These plants vary considerably in their moisture requirements. Some are capable of growing under a wide variety of moisture conditions while others will grow only on moist soils and still others will grow only on moderately dry soils. Generally speaking, the permanent pasture grasses and the clovers do best on moist soils.

Temperature conditions, especially as they relate to frost damage, are of considerable importance in the production of certain grasses suitable for permanent pastures in the southern part of the State.

Through consideration of the various factors discussed, the soils of Florida may be grouped according to the moisture conditions which they present into, (1) excessively dry soils (2) dry soils (3) moderately dry soils (4) moderately moist soils (5) moist soils and (6) wet soils.

The excessively dry soils include the Lakewood and St. Lucie soils and the deep phases of the Norfolk sands. These soils are not suitable for use in the production of any of the approved pasture plants grown in Florida at the present time.

The dry soils include all of the other well drained sands and all of the loamy sands with the exception of those in the Orlando and Ft. Meade series. Pasture plants which may be used successfully on these soils are Bahia, Bermuda, Centipede and Napier grasses, oats, rye, cowpeas, velvet beans and Alyce clover.

The moderately dry soils include the sandy loams of all the well drained series, except Marlboro, Faceville, Carnegie and Greenville, and the loamy sands of the Orlando and Ft. Meade series. These soils are

[3] In such instances of very poor drainage the water table should be lowered by artificial drainage systems only enough to meet the requirements of the plants grown.

suitable for all of the pasture plants grown in the State with the exception of Carpet, Dallis, Carib and Para grasses, and the clovers.

The moderately moist soils include the well drained sandy loams of the Marlboro, Faceville, Carnegie, Magnolia and Greenville series; the imperfectly drained sandy loams of Fellowship and Dunbar series; and the sands of the Leon series. These soils are generally suitable for all the recommended permanent pasture plants with the exception of Para, Dallis and Carib grasses. Cowpeas, velvet beans and kudzu should not be used on the Leon soils.

The moist soils include the dark gray mineral soils of Portsmouth, Bayboro, Scranton and Manatee series; the gray soils of the Plummer, Bladen, Coxville, Bradenton and Parkwood series; the light gray soils of the Charlotte and Arzell series: and the organic soils of the Okeechobee, Okeelanta and Everglades series and undifferentiated peats and mucks. Of these, the dark gray mineral soils are suitable for all the pasture plants except Kudzu, cowpeas and velvet beans. The gray mineral soils are adapted to all permanent pastures except kudzu, but apparently are not suited to most of the temporary pastures. The light gray soils are rather unproductive even though they are well supplied with water and are not suitable for many of the permanent pasture plants and none of the temporary pastures. Carpet grass, as among those now available, has proven to be the best pasture grass for these soils. The organic soils provide excellent conditions for Dallis, Carib, Napier, Burmuda and Para grasses and for the clovers. However, Carib and Para grass should not be grown where frost hazards are likely to develop unless definite provision is made to take care of the dormant period that will follow. Severe cold, of course, will kill them out.

The wet soils include undrained areas where the water table is above the surface. Soils which occur under these conditions include swamp phases of the poorly drained mineral soils already mentioned and large areas of organic soils. When these are drained, they may be used in the manner indicated for the moist soils.

The foregoing statements are based on the results of research by the Agronomy Department on a limited number of soils in the State. More recently, the Soils Department, in connection with the soil survey program, has attempted to evaluate the results of this research in terms of soil characteristics and to develop productivity ratings of individual soil types for the production of pasture plants under recommended management practices. Although this work is scarcely begun as yet, we feel that some worth while information is being developed. As soil and plant research expands and the soil survey program develops, we should be able to establish more and more specific ratings for each soil type in Florida for the production of each of the adapted pasture plants.

PASTURE FERTILIZATION IN NORTHWEST FLORIDA

J. D. WARNER [1]

Many farmers throughout Northwest Florida have been keenly interested in pasture improvement for a good many years. However, results obtained on open ranges in the past, particularly where improved breeds of cattle have been used, often have been disappointing since they failed to satisfy the simultaneous desire for better cattle and a greater carrying capacity of pasture lands.

The value of improved pastures on small farms is also gaining recognition. This is suggested by the increasing number of requests that are received for information on species of grasses best adapted for permanent pastures in given locations. Taken in conjunction with the lively interest shown in field days over this section of the State, this can well be taken to indicate a real recognition of this phase of the pasture problem on the part of the farmer. This change in attitude, gradual though it has been, is very significant because it serves to focus attention on neglected opportunities that are vital to the agricultural interests of this area. It is safe to say that this problem of pasture management has been recognized by agricultural workers in general for some time though comparatively little has been done about it.

However, when the lands of the North Florida Experiment Station were cleared and a herd of cattle was acquired to graze on untreated wire grass and carpet grass, the whole question, in this way, was forcibly brought to the attention of our Experiment Station workers. In attacking this problem at the North Florida Station the first step consisted of a study of various methods of establishing different kinds of grasses. The species planted included carpet, centipede, Bahia, Dallis, and others. It was soon found that, regardless of the method of seeding grasses, carpet grass soon spread over the entire area and remained the dominant species. Centipede, however, now appears to be gradually encroaching on the carpet grass and may eventually displace it. More recently it has been found that centipede grass affords poor quality herbage and its aggressive nature may therefore present a problem of control rather than one of establishment. These grass species are mentioned and compared in this way because their behavior appears closely related to pasture management.

After some of the so-called improved grasses had been established in the pastures on the Station farm it was found, in due course, that if the condition of the cattle grazing on these pastures was taken as a measure of the effectiveness of the pasture cover, the problem still remained unsolved. This is well illustrated in Figure 1. Thus the second phase of the development program came to deal with the problem of improving the quality of the herbage.

The most logical approach to this question appeared to be the introduction of legumes into the grass sod since, as a rule, they are higher in protein and minerals than are grasses on the same soil. However,

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previous experience had taught that legumes failed to thrive in untreated grass sod. Therefore something of an exploratory experiment designed to determine the fertilizer and lime requirements of four strains of clovers was started in 1936. Four rates of 18% superphosphate, i.e. 250, 500, 1000, and 2000 pounds per acre, were used alone and in conjunction with 4000 pounds of dolomite and 200 pounds of muriate of potash. All were applied to the surface of the carpet-centipede grass sod on well drained Ruston and Norfolk fine sandy loam prior to seeding the clovers.

Figure 1.—Cattle grazing unfertilized carpet and centipede grasses on Norfolk fine sandy loam, at the North Florida Experiment Station, September 1938. (See Location Map, Figure 6.)

For the first time it was definitely demonstrated that an excellent growth of certain clovers can be obtained in Florida on mineral soils of medium to low natural fertility provided the soil environment is made favorable for their growth through the use of appropriate fertilizer treatments. The results of this experiment may be briefly summarized as follows:

First Year

1. Best results were obtained where an application of 500 pounds per acre, or more, of superphosphate was made in conjunction with lime and potash.
2. Phosphate alone stimulated growth more than lime and potash.
3. Lime and potash alone had but little influence on growth.
4. Each of the four strains of clover showed similar response to the various fertilizer treatments.

Clover stimulated the growth of grass markedly.

Second Year (No treatments repeated)

1. The 250 and 500 pound rates of superphosphate proved entirely inadequate for satisfactory growth of all clovers, particularly White Dutch.
2. The 1000 and 2000 pound rates of superphosphate provided sufficient available phosphate for satisfactory growth although definite symptoms of phosphate deficiency began to appear.
3. Hop clover grew more luxuriantly at lower levels of available phosphate than any of the other species used in the test.

Third Year

1. White Dutch clover almost disappeared entirely.
2. Hop clover overran the entire area and remained the dominant species.
3. Cattle grazed on fertilized plots while those not fertilized were scarcely grazed at all.

The results of these early tests have been discussed in some detail because they agree quite fully with those of more elaborate experiments subsequently carried out on the same soil types. However, the later experiments have added essentially the following information:

1. Applications of nitrate are beneficial for the establishment of clovers in a grass sod.
2. Potash deficiency symptoms soon appear on clover where applications of this elements are not repeated annually.
3. Superphosphate is more efficient in stimulating the growth of legumes on Norfolk fine sandy loam soil than is basic slag.
4. Annual applications of superphosphate at the rate of 300-400 pounds per acre are necessary for satisfactory growth of White Dutch clover, and perhaps all other clovers, on Norfolk and Ruston fine sandy loams.

Other facts of lesser importance have been gained from these systematic studies of fertilizer requirements of pasture legumes but at this point we will leave the experimental phase and turn our attention again to what has happened in the development of general pastures on the Experiment Station properties.

Using the results of the experiments discussed above as a guide, all pastures were treated four years ago with a general application per acre of 1 ton of lime, 500 pounds of superphosphate, and 150 pounds of muriate of potash, and were then seeded with a mixture of White Dutch, Hop, and Persian clovers. A good stand was obtained and growth, although not uniformly satisfactory, gave some encouragement the first year. Each succeeding year phosphate applications were repeated and the fourth year potash was also added. The growth and ground coverage have improved each year. At the present time the pastures are carrying slightly less than one mature cow per acre for seven months out of each year. More striking than the carrying capacity, however, is the improved condition of the cattle which is well indicated in Figures

Figure 2.—Purebred and grade Angus cattle grazing a cover of White Dutch clover in its fifth year on Ruston fine sandy loam receiving a ton of lime per acre and an annual treatment of 400 pounds of superphosphate and 50 pounds of muriate of potash. North Florida Experiment Station, April, 1941. (See Location Map, Figure 6.)

Figure 3.—Calves grazing a mixed cover of lespedeza and native grasses (predominantly crab-grass) on Norfolk fine sandy loam developed by treatment with phosphate and potash. North Florida Experiment Station, September, 1941. (See Location Map, Figure 6.)

2 and 3. There is no doubt, whatsoever, that the introduction of clovers in the pastures has had considerable influence on the condition of the animals but it is also evident that the increased mineral content of the grasses resulting from the fertilizer treatments that were made is playing an equally important role. This opinion is supported by the experience of certain farmers in North Florida who have adopted this pasture fertilization program for clover.

THUS IT APPEARS QUITE CERTAIN AT THE PRESENT TIME THAT OUR PASTURE PROBLEM IS FUNDAMENTALLY ONE OF PROPER FERTILIZATION AND MANAGEMENT RATHER THAN A SEARCH FOR A "SUPER PLANT" CAPABLE OF EXTRACTING MINERALS FROM A SOIL WHERE THERE IS BUT LITTLE AVAILABLE. Analysis of herbage from Station pastures at two week intervals throughout the grazing season is in progress and when completed should throw considerable light on the effect of fertilizers and lime on its nutritive value.

Because of a lack of facilities and personnel at the North Florida Station, we have had to depend largely upon general plant response and conditions of the cattle as a measure of the effectiveness of our fertilizer program. Research work in the fields of soil and plant chemistry should give a better understanding of the fundamental problems involved and prove fruitful in advancing our program of pasture improvement in Northwest Florida.

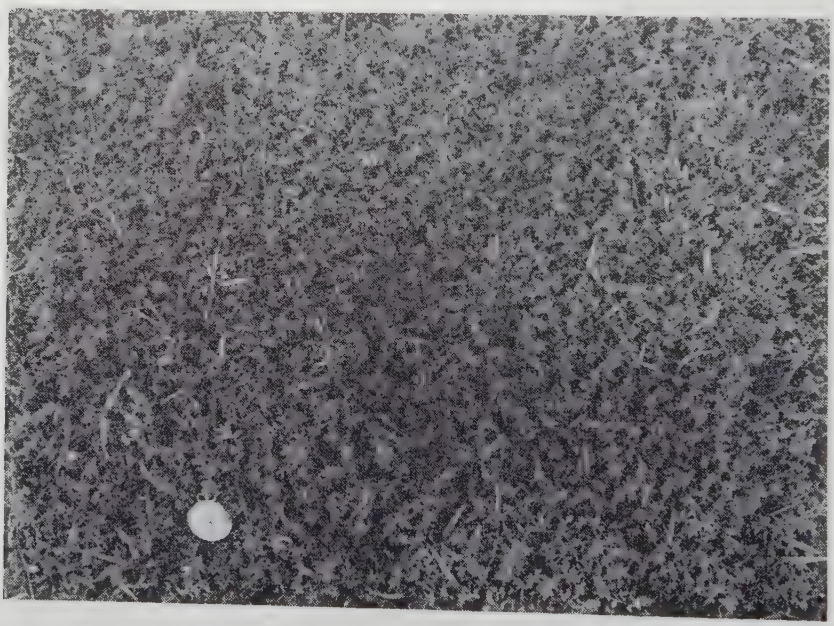

Figure 4.—A thick stand of common lespedeza in its fifth year on Ruston fine sandy loam receiving an annual treatment with 400 pounds of phosphate and 50 pounds of muriate of potash applied to fall seeding of oats following annual discing. Original seeding of lespedeza was in February. North Florida Experiment Station, September, 1941. (See Location Map, Figure 6.)

Figure 5.—Kudzu, an excellent source of grazing and hay, growing on a deep phase of Norfolk fine sandy loam at the North Florida Experiment Station following annual treatment with 400 pounds of superphosphate and 50 pounds of muriate of potash per acre. This field was set as every third row in corn, at six foot intervals in the row, in March, 1940, and cultivated with the corn as long as possible. Manure and superphosphate used at setting. Photographed July, 1941, at sixteen months of age. (See Location Map, Figure 6.)

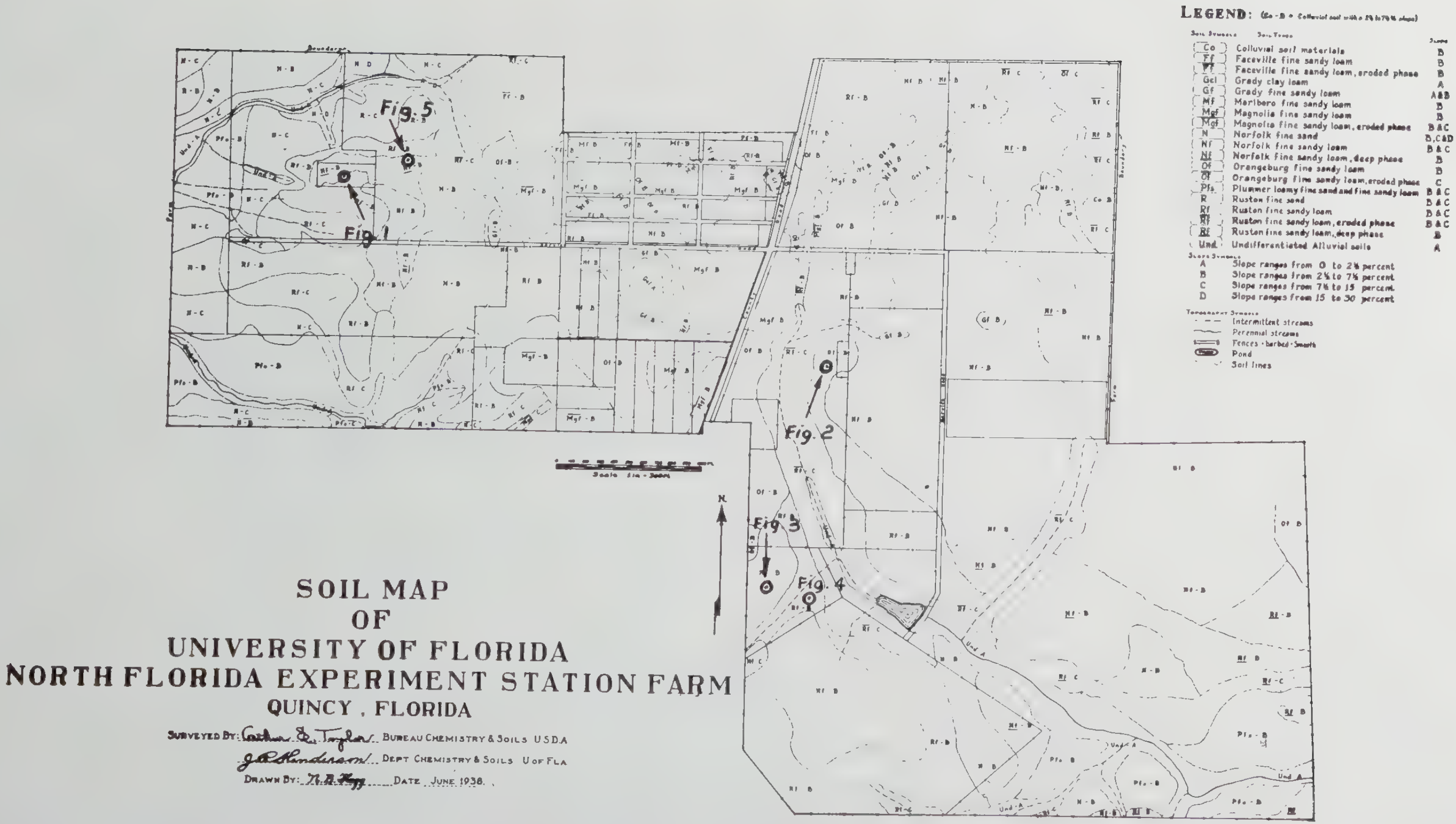

Figure 6.—Soil map of the North Florida Experiment Station showing the distribution of the various soil types listed in the legend; also the field location of the photographs used in this discussion, including the direction of the view in each case where a landscape is involved.

FERTILIZING PASTURE PLANTS ON LEON FINE SAND AND RELATED TYPES OF THE FLORIDA FLATWOODS

R. E. Blaser, F. B. Smith and G. M. Volk [1]

Pasture research conducted in Florida shows that various species of pasture plants differ greatly in their nutritional requirements. This being the case, it is evident that the fertilizer needs of individual species should be carefully studied.

This paper deals with only some of the nutritional studies conducted with various pasture species. Composition and growth are the critical factors used to interpret fertilizer requirements and response. Details of experimental design are eliminated and only pertinent portions of the data are included to simplify the discussion.

FERTILIZER TESTS WITH CARPET GRASS

Thirty-six fertilizer treatments were applied on established carpet grass sods on four different soils during March, 1937. The effects of fertilizer mixtures on growth and chemical composition of carpet grass on a Bladen fine sand are given in Table 1. Without fertilization carpet grass produced 156 pounds per acre during the early season as com-

TABLE 1. The Chemical Composition and Yield of Carpet Grass as Influenced by Lime and Fertilizer Treatments on a Bladen Fine Sand, Dinsmore, Florida.

Lime and Fertilizer (Pounds per Acre)[1]				Chemical Compostion[2]				Yield, (pounds per acre)[3]
Lime	N	P_2O_5	K_2O	Calcium (per cent)	Phosphorus (per cent)	Potassium (per cent)	Nitrogen (per cent)	
0	0	0	0	.355	.134	.640	1.869	136
2000	72	144	100	.573	.234	.794	1.904	1058
0	72	144	100	.395	.161	.667	1.918	743
2000	72	0	200	.254	.107	.874	1.915	628
2000	72	144	0	.395	.174	.401	1.910	638
0	0	144	100	—	—	—	—	157
0	72	0	0	.294	.100	.366	1.893	408
Least significant difference P = .05				.051	.012	.147	***	189
Least significant difference P = .01				.070	.016	.203	***	251

[1] Lime—ground limestone; N—50/50 mixture of nitrate of soda and sulfate of ammonia, broadcast annually in two applications; P_2O_5 (18% superphosphate), K_2O (muriate of potash), and lime given in total pounds per acre applied during four year period. N was applied annually.

[2] Oven dry basis.

[3] Dry weight yields are means of three clippings (April 17, May 9, and May 28, 1940). Chemical analyses were made from clippings taken on May 9, 1940.

*** Not significant according to "F" test.

[1] Associate Agronomist, Soil Microbiologist and Soil Chemist, respectively, Florida Agricultural Experiment Station, Gainesville.

pared to 408 pounds when treated with 36 pounds of nitrogen applied in March. When lime and minerals supplemented the nitrogen the early season yield was 1,058 pounds per acre. A superphosphate-potash mixture produced 157 pounds of grass per acre. When lime, superphosphate or potash were omitted from the lime and complete fertilizer mixture the grass yields were significantly lower. It is thus evident that the growth response of established carpet grass pastures is primarily to nitrogen, but lime, superphosphate and potash greatly increase the efficiency of nitrogen.

The quality of carpet grass also was markedly improved by fertilization as evidenced by its increased calcium, phosphorous and potassium content when treated with lime and a complete fertilizer as compared to unfertilized grass (Table 1). Carpet grass fertilized with nitrogen alone was relatively low in calcium, phosphorus and potassium, substantiating the fact that in this particular trial carpet grass growth was also limited by nutrient elements other than nitrogen. The omission of lime, superphosphate or potash from the lime and complete fertilizer combination resulted in a reduction of the calcium, phosphorus or potassium content of carpet grass, respectively.

When potash was omitted from the complete fertilizer mixture supplemented with lime, the leaf tips of carpet grass became brown and seared. Phosphorus deficiency, indicated by dark purplish-green leaves, resulted when superphosphate was omitted from the complete fertilizer.

Additional experiments were established to study sources of phosphastes for clovers and carpet grass. Plucked samples from carpet grass fertilized on six soil types were made in June, 1940. Detailed analysis of carpet grass treated with fertilizer mixtures and sources of phosphates are given for Leon fine sand in Osceola County (Table 2). Superphosphate, basic slag, and rock and colloidal phosphates all increased the phosphorus content of carpet grass greatly. The calcium and potassium content of the grass also was increased.

TABLE 2.—Effect of Fertilizer Mixtures and Sources of Phosphorus on the Chemical Composition of Carpet Grass Grown on a Leon Fine Sand, Kissimmee, Florida.

Fertilizer Treatment[1] (Pounds per Acre	Chemical Composition[2]			
	Calcium (per cent)	Phosphorus (per cent)	Potassium (per cent)	Nitrogen (per cent)
No Fertilizer	0.391	0.145	0.794	1.889
1 ton lime, 600 lbs. 0-16-8	0.491	0.236	0.915	1.875
3000 lbs. rock phos., 50 lbs. K_2O	0.437	0.283	0.991	1.878
3000 lbs. colloidal phos., 50 lbs. K_2O	0.424	0.259	0.950	1.885
1500 lbs. basic slag, 5$ lbs. K_2O	0.451	0.242	1.090	1.879

[1] Fertilizer applied in 1938, grass plucked in June, 1940.
[2] Oven dry basis.

The mean effects of adding the elements phosphorus, calcium and potassium (irrespective of sources of phosphorus) to five different soil

types are given in Table 3. The calcium, phosphorus and potassium contents of the forage were increased 34 percent. 83 percent and 19 percent, respectively, when compared with unfertilized carpet grass. Fertilization also increased the nitrogen content slightly. The magnesium content was less for the fertilized than the unfertilized grass.

TABLE 3.—MEAN EFFECTS OF FERTILIZATION ON THE CHEMICAL COMPOSITION OF CARPET GRASS TAKEN FROM FIVE SOIL TYPES.

Treatment [1]	Chemical Composition [2]				
	Calcium (per cent)	Phosphorus (per cent)	Potassium (per cent)	Magnesium (per cent)	Nitrogen (per cent)
Not Fertilized	0.354	0.154	0.677	0.338	1.709
Fertilized	0.475	0.263	0.818	0.249	1.811
Per cent increase or decrease	34	83	19	—37	17

[1] Fertilizer applied in 1938, grass plucked in June, 1940.

[2] Composition data for fertilized grass are means of the fertilizer treatments given in Table 2 for Leon and Portsmouth fine sand in Osceola County, and peaty muck in Polk County, Immokalee fine sand in DeSoto County, Plummer fine sand in Hardee County.

FERTILIZER TESTS WITH LESPEDEZA

Fertilizer tests with lespedeza were initiated on several different soil types in 1939. The treatments used included mixtures of lime, potash

TABLE 4.— CHEMICAL COMPOSITION OF LESPEDEZA AS INFLUENCED BY LIME AND FERTILIZER TREATMENTS ON A LEON FINE SAND, GAINESVILLE, FLORIDA.

Fertilizer Treatment (Pounds per Acre) [1]	Chemical Composition [2]				
	Calcium (per cent)	Phosphorus (per cent)	Potassium (per cent)	Nitrogen (per cent)	Magnesium (per cent)
Lime, 1500, 450 lbs. 0-16-8	1.02	.18	.38	2.53	.38
Lime 1500, K_2O 36 lbs.	1.07	.12	.35	1.97	.35
Lime 1500, P_2O_5 72 lbs.	.89	.20	.22	2.38	.35
K_2O 36 lbs., P_2O_5 72 lbs.	.93	.15	.29	2.18	.24
No fertilizer	.57	.12	.31	1.85	.30
"F" Test	**	*	*	**	—

[1] Fertilizer was applied in 1938, lespedeza analyzed in 1939. Generally similar results were obtained from identical fertilizer tests on Plummer, Bladen, and St. Johns types.

[2] Over dry bases.

* Mean differences significant according "F" Test ($P = .05$).

** Mean differences highly significant according "F" Test ($P = .01$).

and various sources of phosphate. Best growth occurred when lespedeza was treated with 1500 pounds of lime and 450 pounds of 0-16-8 fertilizer. When superphosphate was omitted from the fertilizer mixture the lespedeza was low in phosphorus (Table 4) and the plants showed acute phosphorus deficiency in the form of dark green leaves with purplish leaf margins and veins. Potassium deficiency symptoms, yellowish leaves with subsequent burning of leaf tips, occurred when this element was omitted from the lime, superphosphate and potash mixture. The calcium, phosphorus and potassium content of lespedeza was increased significantly by treatment with lime, superphosphate and potash, respectively (Table 4).

Good lespedeza growth was also produced when treated with 3000 pounds of colloidal or rock phosphates, or 1500 pounds of basic slag with 36 pounds of potash (K_2O) per acre. Lime applied with rock or colloidal phosphates produced better lespedeza growth than did the use of the latter two sources of phosphorus without lime.

FERTILIZER TESTS WITH CLOVERS

It is known that the sandy soils of Peninsular Florida must be supplied with calcium, phosphorus and potassium in order to grow clovers efficiently.[2] Good growth commonly follows a treatment of one ton of lime and 600 pounds of a 0-16-8 fertilizer per acre. To simplify discussion, this lime and fertilizer treatment will be called the "standard treatment".

Several experiments have been carried out on a number of different soil types to compare dolomitic and ground limestone and sources of phosphates. All treatments were seeded with a mixture of California bur and White Dutch clover.

The relative growth and percentage of California bur and White Dutch clover, when treated with several different fertilizer combinations on two soil types, are given in Table 5. Dolomitic limestone was inferior to the high calcium limestone when used with superphosphate and potash on the Leon fine sand. However, these two sources of lime did not produce significantly different yields on the Plummer fine sand.

When rock phosphate at the rate of 3000 pounds per acre replaced the lime and superphosphate, these clovers produced less than with the standard treatment on both soil types. California bur clover made meager growth on both soils when fertilized with this combination, as evidenced by the fact that more than 90 percent of the vegetation was White Dutch clover.

When the rock phosphate-potash mixture was supplemented with one ton of lime per acre the relative yield was 81 as compared to 28 when lime was omitted from the fertilizer mixture on the Leon series. On the Plummer fine sand the clover treated with the rock phosphate-potash mixture gave a relative yield of 56 as compared to 19 when lime was supplied. It appears that the application of lime to the Plummer fine sand raised the pH of the soil sufficiently to retard the availability of phosphorus from rock phosphate. This fact is substantiated by the

[2] Clover studies in Florida. Fla. Agr. Exp. Sta. Bul. 325, 1938. Winter clover pastures for Florida. Fla. Agr. Exp. Sta. Bul. 351, 1940.

TABLE 5.—CALIFORNIA BUR AND LOUISIANNA WHITE CLOVER YIELDS AS AFFECTED BY FERTILIZATION ON TWO SOIL TYPES.

Fertilizer Treatment * Pounds per Acre	Leon fine sand (pH 4.8)		Plummer fine sand (pH 5.3)	
	Dry Yield Lbs. (Relative)	White Clover (per cent of cover)	Green Yield Lbs. (Relative)	White Clover (per cent of cover)
Ca 2000, 600 lbs. 0-16-8	100	65	100	41
Mg 2000, 600 lbs. 0-16-8	57	68	104	53
Pr 3000, K_2O 48 lbs.	28	98	56	91
Pr 3000, Ca 2000, K_2O 48 lbs.	81	52	19	15
Pr 3000, Ca 500, K_2O 48 lbs.	70	82	31	44
Pr 3000, P_2O_5 36 lbs., K_2O 48 lbs., Ca 500	67	87	110	52
Pbs 2000, K_2O 48 lbs.	56	58	74	44
Least significant difference P = .05	13	20	11	20
P = .01	18	25	15	28

* Ca—lime
Mg—dolomite
Pr—32% rock phosphate
Pbs—basic slag

preponderance of California bur clover[3] on plots treated with the rock phosphate-potash and lime mixture on the Plummer soil. The addition of lime to the rock phosphate-potash mixture increased the percentage of California bur clover significantly on both tests, indicating that California bur clover requires more lime than White Dutch clover.

When 500 pounds of lime was supplied to the rock phosphate-potash mixture the yield trend was similar to that for the ton rate. The addition of 200 pounds of superphosphate to the rock phosphate, lime and potash mixture improved growth significantly on the Plummer fine sand, but was ineffective on the Leon fine sand. It is evident that lime retards the availability of phosphorus in rock phosphate on the Plummer soil during the first year.

The growth of the clovers, when fertilized with 2000 pounds basic slag and potash, was satisfactory but inferior to the standard fertilizer treatment referred to above.

The chemical composition of California bur and White Dutch clover as related to sources of phosphates and lime in various mixtures on Leon fine sand is given in Table 6.

The calcium content of both California bur and White Dutch clovers was higher when treated with high calcic limestone than with dolomite. The magnesium content of both clovers was highest with the dolomitic limestone treatment.

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[3] Tests show that California bur clover is tolerant of much lower levels of phosphorus than White Dutch clover.

TABLE 6.—INFLUENCE OF SOURCES OF PHOSPHORUS AND LIME ON THE CHEMICAL COMPOSITION OF TWO CLOVERS IN 1941, LEON FINE SAND, GAINESVILLE, FLORIDA.

Fertilizer Treatment[1] Pounds per Acre	Clover	Chemical Composition[2] Calcium (per cent)	Phosphorus (per cent)	Potassium (per cent)	Magnesium (per cent)	Nitrogen (per cent)
Ca 2000, 600 lbs. 0-16-8	White D.	1.89	0.43	1.35	0.34	3.98
	Cal. bur	1.90	0.55	0.92	0.27	3.43
Mg 2000, 600 lbs. 0-16-8	White D.	1.65	0.45	1.30	0.45	4.11
	Cal. bur	1.62	0.54	0.79	0.54	3.38
Pr 3000, K_2O 48 lbs.	White D.	1.40	0.50	1.74	0.43	4.22
	Cal. bur ***	......	......	......	......	......
Pr 3000, K_2O 48 lbs. Ca 500	White D.	1.73	0.42	1.33	0.36	3.88
	Cal. bur	1.75	0.48	0.79	0.31	2.96
Pr 3000, K_2O 48 lbs. Ca 2000	White D.	2.00	0.40	1.33	0.34	3.76
	Cal. bur	2.16	0.46	1.08	0.29	3.07
Pbs 2000, K_2O 48 lbs.	White D.	1.51	0.44	1.37	0.39	3.03
	Cal. bur	1.43	0.58	0.75	0.31	3.28
"F" Test	White D.	**	**			
	Cal. bur	**	*		**	

[1] Ca—lime
Mg—dolomite
Pr—32% rock phosphate
Pbs—basic slag

[2] Oven-dry basis
* Mean differences significant P = .05
** Mean differences highly significant P = .01
*** Not sufficient California bur clover for analysis

White Dutch clover treated with the rock phosphate-potash mixture was slightly higher in phosphorus content than when treated with the standard treatment, but the calcium content of this clover was significantly higher under the latter condition. The higher phosphorus content in the first instance was probably the result of lower yield because calcium was limiting. An application of 500 to 2000 pounds of lime per acre to the rock phosphate-potash mixture increased the calcium content of White Dutch clover when compared with the rock phosphate-potash mixture without lime. However, the high rate of lime applied with the rock phosphate-potash mixture resulted in a lower phosphorus content of White Dutch clover.

A 2000 pound rate of basic slag produced clovers lower in calcium, but equal in phosphorus content when compared with those receiving the standard treatment.

Eight clover variety experiments were laid out on several different soil types to compare their fertilizer requirements under various conditions. Yield estimates were made on all of the tests, while nodule counts were made on two of them. The results were similar for the various areas. Therefore, only the data from the Leon fine sand at Gainesville are given.

The fertilizer treatments and clover varieties are given in Table 7. Taking the yield of the five Trifolium clovers from the standard treatment as 100 for purposes of easy comparison, that of the plots receiving 3000 pounds of rock phosphate and 48 pounds of potash (K_2O) was

TABLE 7.—NODULATION AND YIELD OF CLOVERS AS AFFECTED BY FERTILIZATION ON A LEON FINE SAND, GAINESVILLE, FLORIDA.

Fertilizer Treatment [1] Pounds per Acre	Five Trifolium Clovers [2]		Four Medicago Melilotus Clovers [3]	
	Nodules	Rel. Yield [4]	Nodules	Rel. Yield [4]
Ca 2000, 600 lbs. 0-16-8	45	97	29	76
Ca 4000, 600 lbs. 0-16-8	51	100	27	100
Pr 3000	33	99	2	11
Pr 3000, Ca 750, K_2O 48 lbs.	48	116	17	78
Pr 3000, Ca 750, P_2O_5 36 lbs., K_2O 48 lbs.	47	105	19	70
Pr 3000, P_2O_5 36 lbs., K_2O 48 lbs.	25	59	2	5
Pr 6000, K_2O 48 lbs.	35	99	2	15
"F" Test	**	**	**	**

[1] Ca—lime
Pr—rock phosphate

[2] Trifolium clovers include White Dutch, Persian, Hop, Red, and Alsike clovers.

[3] Medicago-Melilotus clovers include California bur, Black Medic, Giant Southern bur, and Hubam sweet clovers.

[4] Estimated

** Mean differences highly significant P = .01

found to be 99. The number of nodules per plant was found to be 51 and 33, respecively, for the two treatments. The addition of lime at the rate of 750 pounds per acre increased the relative yield to 116 and the mean number of nodules per plant to 48. The addition of 36 pounds of P_2O_5 per acre (as superphosphate) to the rock phosphate-potash mixture produced a mean relative yield of only 59 and also gave inferior nodulation. When the rock phosphate-potash mixture was supplemented with lime and superphosphate the relative yield was 105 and the number of nodules per plant averaged 47. Rock phosphate applied at a rate of 6000 pounds per acre with potash gave results similar to those of the 3000 pound rate for the five Trifolium clovers.

On this same basis the four Medicago-Melilotus clovers showed a mean relative yield of only 11 when treated with 3000 pounds of rock phosphate and 48 pounds of potash (K_2O) per acre as compared to 100 when fertilized with the standard treatment. The mean number of nodules per plant was 27 for this group of clovers fertilized with the standard treatment as compared with 2 when the clovers were treated with the rock phosphate-potash mixture. The addition of lime or lime and superphosphate to the rock phosphate-potash mixture greatly improved nodulation and growth. This group of clovers, treated with rock phosphate at the rate of 6000 pounds per acre along with potash, produced a mean relative yield of 15 and an average of 2 nodules per plant (Table 7).

This comparison of the growth responses of the Trifolium and Medicago-Melilotus clover groups shows that on these soils the latter group definitely requires more lime than the former. Other tests also show that the Trifolium clovers require more phosphorus than the Medicago-Melilotus group.

SUMMARY AND CONCLUSIONS

Plant species used for pastures differ greatly in their nutritional requirements. Plant responses to fertilizers also vary with soil types. The importance of studying individual plant species on various soils is evident.

The phosphorus, calcium, and potassium content of carpet grass, lespedeza, and clovers was altered significantly by fertilization. Certain potash and phosphorus deficiency symptoms of pasture plants are also reported.

A balanced fertilizer program will increase the quality and quantity of pasture plants greatly.

FERTILIZER REQUIREMENTS OF GRASS AND CLOVER ON THE PEAT SOILS OF THE FLORIDA EVERGLADES

J. R. NELLER [1]

The experimental plots discussed in this paper were located in a pasture at the Everglades Experiment Station on typical Everglades peat where the water table is held at 18 to 24 inches below the surface of the soil most of the time. This pasture was planted to Dallis grass in 1932. The earlier fertilizer experiments carried out on it have already been reported (Bul. 338 U. of Fla. Agr. Exp. Station). The procedure has been to fence off areas in the pasture from time to time within which replicated plots of various fertilizer treatments were established. Response to these plant food additions were measured by making a record of yields that were clipped from each area. These clippings were made often enough to keep the grass in a vegetative state somewhat comparable to that obtained by grazing.

In preparation for the planting of this pasture in 1932 the soil was given a general treatment of copper sulfate at 50 pounds and of muriate of potash at 200 pounds per acre. In December 1934, the pasture was top dressed with 50 pounds of triple superphosphate (44 percent P_2O_5) and 100 pounds of muriate of potash (50 percent K_2O) per acre. A fertilizer study was started in November 1935, and results reported up to 1938 (Bul. 338) show that grass yields would have been materially higher had the pasture received more plant food.

EXPERIMENTAL

In November of 1938 a third area was fenced off in this pasture and divided into 48 plots comprising 12 treatments. The mixtures for this study were made up according to the formulae listed in Table 1 where a 3-6-12 (N-P-K) mixture, at a rate of 500 pounds per acre, was used as a base. Treatments 8 to 12, inclusive, were applied in June as well as in November whereas Treatments 2 to 7, inclusive, were made only in November. The sulfates of copper, manganese and zinc were used annually at the rates of 25, 25 and 6 pounds per acre, respectively. The other source materials were ammonium sulfate, acid phosphate and muriate of potash.

The plots were 1/400 acre in size with 3½ foot borders. The grass of these borders or alleys was cut out with a sickle mower which had a 3½ foot blade. This was done in preparation for cutting and weighing the grass from the plots.

In the fall of 1937 this Dallis grass pasture was given a broadcast seeding of White Dutch clover. A fairly good stand of clover was in evidence that winter as well as the next. In later years not so much clover was to be noted except on the more heavily fertilized plots such as No. 6 receiving the 2P3K (0-12-36) treatment. Figure 1 is a general view of the plots taken March 14, 1940, in which very little of the grass

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[1] Biochemist in Charge, Everglades Experiment Station, Belle Glade.

and no clover can be seen in the check or unfertilized plots 1D and 1C. Clover as well as a better growth of grass is in evidence in Plots 4D, 9D and 6C for which the treatments and grass yields are given in Tables

Figure 1.—General view of the pasture fertility plots after the borders had been removed for the cuttings recorded on March 14 (Table 2), with emphasis on treatments 1C, 1D, 4D, 6C, and 9D.

Figure 2.—A representative check plot (center, behind stake) at the time of the March 14 cutting, Table 2. These checks received the general pasture fertilizer treatment recorded for 1932 and 1934.

1 and 2. Figure 2 shows the nature of growth on plots that received no fertilizer; Figure 3, potash only; Figure 4, phosphate and potash; and Figure 5, double the phosphate and triple the potash of Figure 4.

As illustrated by these views potash alone induced considerable growth of clover and of grass while phosphate with potash increased

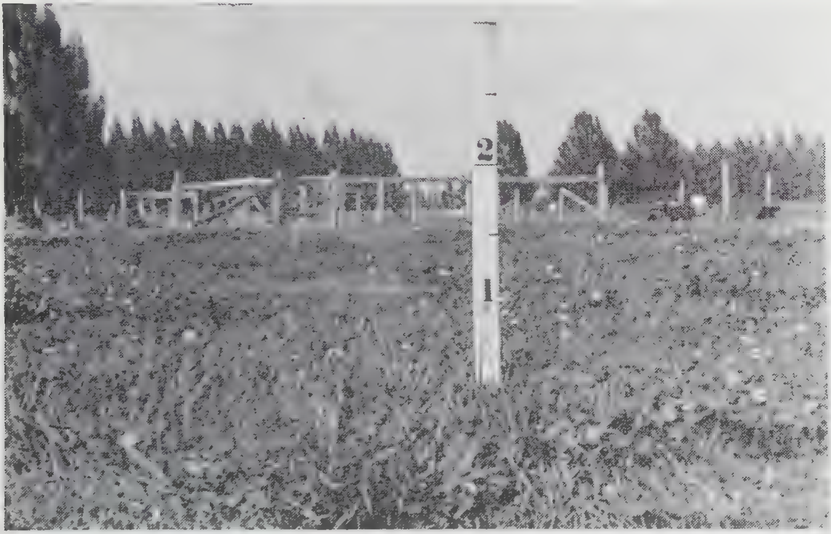

Figure 3.—A representative plot of the potash, only, treatment (No. 2, Tables 1 and 2) at the March 14 cutting.

Figure 4.—Response to Treatment 3 as represented by an 0-6-12 formula at the March 14 cutting.

growth somewhat more. On plots where the amounts of phosphate and potash were doubled and trebled, respectively, the clover was very much in evidence (Figure 5). The average weight of grass and clover for the four replicated plots, as obtained when these photographs were made, are given for cutting No. 9 of Plots 1, 2, 3, and 6 of Table 2. Comparison of Figures 5 and 6 and of yields from Plots 6 and 7 for

Figure 5.—Response to Treatment 5 (0-12-36) at the March 14 cutting.

Figure 6.—Response to Treatment 6 (3-12-36) at the March 14 cutting.

TABLE 1.—GREEN WEIGHT RECORDS FROM DALLIS GRASS-CLOVER FERTILITY PLOTS FOR 1939. AVERAGES FROM FOUR PLOTS IN POUNDS PER ACRE.*

Treatment No.	Fertilizer Formula	Harvest number and date								Total Tons per Acre
		1 Jan. 24	2 March 3	3 April 11	4 May 16	5 June 21	6 Aug. 8	7 Sept. 23	8 Nov. 7	
1	Ck	4,000	7,860	3,260	7,600	10,600	4,640	6,580	1,960	23.25
2	K	7,460	10,220	5,660	10,240	13,720	5,040	7,340	2,560	31.12
3	PK	10,460	14,200	7,560	13,360	11,340	5,540	7,040	2,600	36.05
4	P2K	11,760	13,920	8,980	12,580	11,460	5,500	7,460	2,880	37.77
5	2PK	12,120	14,640	8,600	13,280	10,440	5,220	6,860	2,280	36.72
6	2P3K	13,960	16,280	12,640	15,420	12,080	5,880	7,740	2,460	43.23
7	N2P3K	15,540	15,880	12,360	14,860	12,300	5,260	6,740	2,980	42.96
8	PK X 2	10,860	12,980	7,680	11,040	9,880	9,740	13,480	5,640	40.65
9	P2K X 2	13,880	15,960	8,800	12,300	10,820	9,220	15,660	6,720	46.68
10	2PK X 2	12,180	14,400	9,940	12,460	10,260	9,380	13,420	5,460	43.75
11	2P3K X 2	12,900	16,640	12,160	17,180	14,320	8,500	14,060	10,860	53.31
12	N2P3K X 2	14,620	16,680	11,420	14,980	11,780	8,960	14,740	11,960	52.67

* Average dry matter, oven dry basis, 19.06 per cent of green weight.

TABLE 2.—GREEN WEIGHT RECORDS FROM DALLIS GRASS-CLOVER FERTILITY PLOTS FOR 1940. AVERAGES FROM FOUR PLOTS IN POUNDS PER ACRE.*

Treat-ment No.	Fertilizer Formula	Harvest number and date						Total Tons per Acre
		9	10	11	12	13	14	
		March 14	April 18	May 25	June 19	July 24	Sept. 23	
1	Ck	240	1,160	1,000	5,380	3,460	2,452	6.85
2	K	5,440	11,008	5,480	10,720	7,320	3,792	21.88
3	PK	8,080	16,220	6,220	11,790	5,452	2,612	25.19
4	P2K	14,620	15,048	6,300	9,030	5,200	2,872	26.54
5	2PK	9,400	14,748	5,940	9,260	2,912	3,092	22.68
6	2P3K	16,220	19,180	11,480	11,610	6,372	2,952	33.91
7	N2P3K	16,620	20,008	12,720	10,970	6,840	3,600	35.38
8	PK X 2	12,380	16,048	7,580	9,040	14,264	3,360	31.34
9	P2K X 2	14,060	19,160	11,040	11,850	14,760	3,670	37.27
10	2PK X 2	9,320	17,688	8,260	11,170	15,200	3,672	32.66
11	2P3K X 2	12,960	22,220	13,900	14,540	13,940	4,012	40.79
12	N2P3K X 2	15,600	22,368	16,220	12,480	12,960	4,052	41.84

* Average dry matter, oven dry basis, 18.26 per cent of green weight.

March 14 (Table 2) shows that the addition of ammonium sulfate to the fertilizer mixture was without significant effect.

Total yields as given in tons per acre for 1939 (Table 1) and for 1940 (Table 2) indicate much the same trend as discussed above for the March 14 cutting. A further comparison of Tables 1 and 2 shows how very marked the response to phosphate, and especially to potash, becomes after clipping and removing the growth for a season. Yields from Treatments 3, 4 and 5 show that an increase in potash without increasing phosphate (PK versus P2K) as well as an increase in phosphate without increasing potash (PK versus 2PK) was without material effect. When both phosphate and potash were increased (Treatment 6) there was a marked increase in yields for 1940 as well as for 1939. These results indicate that the ratio of phosphate to potash in the basic formula 3-6-12 is about correct.

In general the extra June application (Treatments 8 to 12) increased the growth somewhat, but not nearly to the extent brought about by the annual treatments of 2 to 6, inclusive, when compared with the growth on plots receiving no treatment. Treatment 9 (P2K twice a year, Table 1) was better than Treatment 8 (PK twice a year) whereas Treatment 10 (2PK twice a year) was not. The same relationship held for the second year's results (Table 2). It may also be observed that the highest yields for both years were from Treatment 11 (2P3K twice a year) and Treatment 12 (N2P3K twice a year). The inclusion of a source of nitrogen (Treatment 12) was without significant effect.

These relationships pointed the way to the next phase of the investigation which is now under way in an adjacent area where the plant food requirements are being studied by correlating herbage yields with chemical determinations of plant food in the soil in an available state.

SUMMARY

A fertilizer study has been under way in an Everglades pasture for the past nine years. This pasture was planted to Dallis grass and White Dutch clover on a typical sawgrass peat of the upper Everglades that is under water control through the use of low lift pumps.

In 1934, 1935 and 1938 fertility plots were established on different areas of the pasture and the growth responses were compared with those of the check plots which represented the fertility level of the untreated areas. The entire pasture was given a fertilizer treatment in 1932 and 1934.

In general, definite responses were obtained from these treatments. This paper discusses the extent of these yield responses and the relative effects of the use of different increments of various fertilizer constituents.

White Dutch clover was most in evidence where the largest additions of phosphates and potash had been made.

PHYSIOLOGICAL RESPONSE OF SOME GRASSES TO DIFFERENT FORMS OF NITROGEN

W. A. Leukel and R. B. French [1]

One approach to proper pasture fertilization embodies fundamental studies of plant growth and metabolism. Several phases of such studies are presented in the following summary. These include results obtained on the growth and metabolism of Bahia and Sudan grasses as influenced by ammonia and nitrate sources of nitrogen with varying levels of phosphorus and potassium.

Bahia grass was grown in sand cultures using ammonia nitrogen in one series with normal, high and low levels of phosphorus and potassium and nitrate nitrogen in another with similar levels of phosphorus and potassium. The high level of phosphorus and potassium was ten times that of the normal or control, while the low level was only one tenth of the control. Bahia grass showed a vigorous healthy growth where ammonia was used as a source of nitrogen, but a chlorotic condition developed where nitrates were used to furnish this element. To overcome this iron chlorosis, the latter cultures were supplied with twice the quantity of iron provided the former.

The reaction of the nutrient solutions in both series (NO_3 and NH_3) was close to neutral (pH 7.0) with the exception of the cultures containing high phosphorus which were somewhat more acid. During the early growth of the plants little difference was noted between the reaction of the nutrient solutions and their leachings. With the development of a larger root system, however, a marked change took place. In the instance of the plants receiving nitrogen in the form of nitrates, there was a shift toward a higher pH, but this was less marked in the case of the well buffered high phosphate solution. On the other hand, leachings from the plants receiving nitrogen in the form of ammonia showed a decrease in pH in all instances.

In terms of top growth, the plants receiving ammonia nitrogen gave a considerably greater yield than those receiving nitrogen in the form of nitrates except in the case of the high phosphate treatment. Here a heavier top growth was produced from the nitrate treated plants. In the instance of the ammonia treated plants, those receiving normal and low phosphorus produced twice as much top growth as the nitrate treated plants receiving similar levels of phosphorus. Greater yields were likewise shown for the different levels of potassium in the ammonia series.

A comparison of the inorganic elements found in the top growth of the plants receiving the two sources of nitrogen showed interesting trends. The content of calcium and magnesium in the tops of the nitrate and ammonia series showed similar trends for the different levels of phosphorus and potassium but were consistently higher in the former. The content of phosphorus also showed a similar trend in the vegetative top growth of both the nitrate and ammonia series, but was twice as great in

[1] Agronomist and Associate Chemist, respectively, in the Agronomy and Home Economics Departments, Florida Agricultural Experiment Station, Gainesville.

the latter series. Potassium being a more labile element, and serving many functions in the plants' metabolism, failed to show regular association with the different treatments in a comparison of the two series involving different nitrogen sources.

Other suggestive trends were found in the content of the different inorganic elements in the top growth for the different treatments in each series. Thus calcium showed little variation in the control cultures or in the high phosphorus and low phosphorus treatments in both series, nitrate and ammonia. However, a decrease in the content of this element was found in the high potassium treatment and an increase for the low potassium treatment in both series. A similar variation in the percentage of magnesium was found for the high and low potassium treatments, but this variation was more marked for the low potassium treatment in the nitrate series and for the high potassium treatment in the ammonia series.

The use of nitrogen from the two different sources not only caused such results as a wide variation in the content of different inorganic elements in the top growth, but helped to illustrate fundamental relations between various treatments and the synthesis of different carbohydrate and nitrogen fractions by the plant. In general, most of the higher carbohydrate fractions showed a higher level in the top growth of the plants from the nitrate series. These higher contents of carbohydrate fractions—namely, sugars, polysaccharides and total carbohydrates—in the top growth of the plants from the nitrate series were associated, in all instances, with lower percentages of the different organic nitrogen fractions, namely assimilated, protein and amino-acid nitrogen. Total nitrogen was likewise found lower in each of these instances. On the other hand, the lower trend in the content of the carbohydrate fractions in the top growth of plants from the ammonia series in all instances was associated with higher levels of the above mentioned organic nitrogen fractions including higher total nitrogen. Nitrate treated plants were higher in their content of nitrate nitrogen while ammonia treated plants showed a higher level of ammonia nitrogen.

The greater top growth produced in the ammonia treated series may be attributed to the greater ease with which this form of nitrogen can be transformed into higher nitrogen compounds by the plant. Nitrates, before being utilized by the plant in its metabolism, must be reduced to nitrites through enzyme action which takes place most readily when the plant has a proper inner environment of phosphorus. On the other hand, ammonia nitrogen is transformed into higher nitrogen compounds by the plant very readily, even in the presence of lower levels of phosphorus and other inorganic elements.

The lower percentages of carbohydrates in the ammonia treated plants, especially reducing sugars, indicates that a greater portion of the early formed carbohydrates are combined with nitrogen for the formation of higher nitrogen compounds. This correlation was found to be true in that there were higher levels of these nitrogen compounds in the ammonia treated plants.

The greater top growth produced by the ammonia treated plants can be further attributed to the best utilization of iron by these plants. With only one-half of the iron supplied to these plants in comparison to that

supplied to the nitrate treated plants, better growth was produced even with considerable iron leached through the sand cultures at all pH levels. On the other hand, nitrate treated plants showed a poor utilization of iron and, furthermore, very little was found in the leachings from the substrata of these cultures.

Further association between some of the inorganic elements in the top growth of the ammonia and nitrate treated plants are revealing. The use of the positive ammonia ion as a source of nitrogen was consistently associated in the plant with a higher percentage level of the negative phosphate ion. On the other hand, the use of the negative nitrate ion as a source of nitrogen was invariably associated in the plant with higher levels of positive calcium and magnesium ions. This correlation did not hold true with the positive potassium ion due to its labile character and the various other functions that it serves.

Sudan grass was incapable of utilizing ammonia nitrogen as its sole source, but responded to an equal mixture of nitrate and ammonia sources. Differences in yields of this grass did not show the marked variations observed in the instance of Bahia grass, but the composition relations showed generally similar trends.

BUSINESS MEETING

President, Dr. F. B. Smith, *Presiding*

A business meeting was called at 8:30 P. M., following the Annual Banquet held in the Florida Union Annex.

MINUTES OF THE BUSINESS MEETING OF THE SOCIETY HELD ON MAY 31, 1940

The Second Annual Meeting of the Society was held in Gainesville, on the campus of the University of Florida, on May 30 and 31, 1940. The opening session, on the afternoon of May 30, was held in conjunction with the Annual Meeting of the Florida State Florists' Association and was organized in the form of a soil clinic. The meeting on the morning of May 31 was in the form of a symposium on "trace" or "micro" elements. The afternoon meeting on the same date was devoted to the consideration of soil organic matter.

The business session of the Second Annual Meeting was held in connection with an informal banquet in the Florida Union Annex on the evening of the 31st. Dr. Michael Peech, having completed a year as Vice-President, was installed as President without formality of election in accordance with the Constitution of the Society. Dr. F. B. Smith was elected Vice-President for the coming year. Mr. H. C. Henricksen was selected by the membership to continue as a member of the Executive Committee. By agreement of the latter committee, Dr. R. V. Allison, retiring President, was appointed Secretary-Treasurer, after the committee, with much regret, had accepted the resignation of Mr. R. A. Carrigan from this post.

APPOINTMENT OF AUDITING COMMITTEE

An Auditing Committee consisting of Mr. R. A. Carrigan, Chairman, Mr. G. H. Blackmon and Dr. R. B. Becker was appointed by the Chair with instructions to examine the financial records of the Society at a time of mutual convenience, and report.

REPORT OF STANDING COMMITTEES

1. *Membership Committee, Dr. R. V. Allison, Chairman*

The membership of the Society is now about 650 though a considerable number of current dues are unpaid. Much of this delinquency will doubtless be overcome with the appearance of the Second Proceedings.

An interesting section of our membership is to be found in Central America and the tropical parts of South America and in the areas of the Caribbean where we now have more than 25 members. A good part of this number is due to the energetic interest and enthusiasm for the work of our good friend down there, Dr. Wilson Popenoe. Many of you will be interested in learning that he recently has been made Director of the new Agricultural School that is now being developed in Honduras largely, as we understand it, as a result of the generous interest of the United Fruit Company in the project. In any event it was this interest of Doctor Popenoe and his associates in the tropics that suggested the emphasis that was given to tropical agriculture in the General Program this morning. We are hopeful that at least a part of this program may be published in the Proceedings in both Spanish and English.

2. *Soil Survey Committee, Senator E. R. Graham, Chairman*
Mr. H. I. Mossbarger, reporting

The Statewide Soil Survey Bill was introduced into the Senate by Senator E. R. Graham where it was passed unanimously. It then was passed by the Lower House of the Legislature under the very capable leadership of Representative Joe C. Jenkins with only a small dissenting vote and received the approval of the Governor on May 26, 1941. The full text of the Law, as presented to the Society by Mr. Mossbarger, follows:

CHAPTER 20454—(No. 246).

SENATE BILL NO. 288

AN ACT to Declare the Need of and Provide Authorization for a Statewide Survey of the Soils of Florida Through the Cooperation of Appropriate State and County Agencies With Proper Bureaus of the United States Department of Agriculture, Designating the Agricultural Experiment Station of the University of Florida as an Agency of the State to Supervise Such Surveys; Providing for the Matching of Federal Funds by the State and Counties or Other Local Agency; Providing for the Publication of Soil Survey Reports and Maps; Making an Appropriation for Carrying Out the Provisions of This Act and Repealing Any and All Laws in Conflict Herewith.

Be It Enacted by the Legislature of the State of Florida:

SECTION 1. That a thorough and careful survey and mapping of the soils of Florida be hereby declared as a matter of legislative policy, basic to (1) the development of intelligent research programs on the agricultural potentialities of the soils of the State; (2) the organization of effective soil conservation and land use planning programs; (3) agricultural extension and home demonstration work; (4) highway and secondary road planning; (5) establishment of equitable land tax assessments; (6) agricultural teaching; (7) the development of a sound body of helpful agricultural information for nation-wide distribution to prospective land owners; and a number of other social and agricultural enterprises of broad public interest.

SECTION 2. That the cost of the survey shall be borne jointly by the State and County or any other local agency and by the Federal Government in a proportion to be determined by the availability of funds and of trained personnel for the purpose.

SECTION 3. That the sum of Ten Thousand ($10,000.00) Dollars be the same is hereby appropriated and set aside annually, not to exceed two years, from the General Revenue Fund, to carry out the provisions of this Act. Any part of such sum of Ten Thousand ($10,000.00) Dollars of State funds used, shall be supplemented by a predetermined amount by any county in which the survey is to be made or by any such county and other local agency where feasible, and the Board of County Commissioners of the several counties of the State are hereby given authority to use such funds as may be budgeted for this purpose.

SECTION 4. That the Agricultural Experiment Station of the University of Florida shall administer this Act and shall be responsible for

the general supervision of this cooperative enterprise between and among federal, state, county and local agencies and that it be charged with the duty of developing an energetic soil survey program for the State accordingly as funds are made available for this purpose from federal, state, county, or other sources.

SECTION 5. That the methods used in the survey shall be the standard procedures developed by the United States Department of Agriculture now in common use: all correlation work shall be carried out jointly by the regular soil survey inspectors of the United States Department of Agriculture in cooperation with representatives of the State Agricultural Experiment Station.

SECTION 6. That the successive selection of units to be surveyed shall be by type areas well distributed over the State, just as far as possible or practicable, especially during the early stages of the program, though determination shall naturally depend, too, on the feeling of need by the people in the area and the willingness of county or other local officials to cooperate.

SECTION 7. That suitable physical, chemical and other analyses of type materials associated with the work of the survey be carried out in the laboratories of the Florida Agricultural Experiment Station or of the proper Bureau of the United States Department of Agriculture.

SECTION 8. The preparation of soil survey reports and maps for such areas surveyed shall be a joint responsibility of state and federal workers, although publication shall be by the United States Department of Agriculture, especially for the purpose of full conformity with the many reports of this same type that are regularly being published for other States where survey work of this type is making notable advances.

SECTION 9. That all laws and parts of laws in conflict with this Act be and the same are hereby repealed.

SECTION 10. That this Act shall take effect July 1, 1941.

Approved by the Governor May 26, 1941.

Filed in Office Secretary of State May 27, 1941.

3. *Methods of Analysis, Dr. L. H. Rogers, Chairman*
Mr. R. A. Carrigan, reporting

Results of the research of certain members of the Methods Committee were presented in the formal program this afternoon. The following studies on methods of analysis have been carried out during the past year by other members of the committee:

Mr. Carrigan, together with Mr. Peterson, a graduate student, developed a spectrographic method for the determination of exchangeable potassium in soils. Additional work comparing the results obtained by this method and a standard chemical method remain to be carried out.

Dr. W. T. Forsee found that it is desirable, in accordance with a suggestion made by Dr. R. H. Bray, to use hydrochloric instead of sulfuric acid in the development of the blue phosphomolybdate color in the determination of phosphorus in soil extracts.

Dr. Rogers made a comparison of three micromethods for the determination of molybdenum in plants and soils. He found that if one gram samples of material (or more) are available, the thiocyanate colorimetric method is satisfactory. If small samples, only, are available a spectrographic method was

preferred. A polarographic method which was developed showed no particular advantages over the other two methods.

4. *Fertilizer Recommendations Committee, Mr. W. L. Tait, Chairman*

A large number of the members of this committee met on April 15, 1941, at the Orange Court Hotel in Orlando. In order to facilitate the work four sub-committee groups were formed with sub-chairmen as follows: Field Crops—Mr. W. E. Stokes; Truck Crops—Dr. F. S. Jamison; Citrus—Mr. H. A. Thullbery; Miscellaneous Horticultural Crops—Mr. G. H. Blackmon.

The best approach to the question of fertilizer recommendations appears to be through a study of the fertilizer information already developed by the Experiment Station and farmers, also by a survey of the comparative importance of various soils in the production of the principal crops in Florida. For this latter mentioned project a questionnaire has been sent to the members of the committee and while several replies have been received it is evident that full response must be forthcoming before any workable data can be assembled. Those who have not already done so are urged to fill in the questionnaire and send to the proper sub-committee chairman, so that this information can be assembled at an early date.

5. *Forest Relationships, Prof. R. H. Westveld, Chairman*

The Committee has concerned itself primarily with getting foresters with whom the members have contact interested in the significance of soils in forestry and with plants for a compilation of literature on forest-soils relationships in Florida. Several pieces of literature of some value were discovered in the preliminary work. The compilation will be undertaken during the current year.

It has been agreed that in any investigational work that is done in the field of silviculture, ecology, and related fields, the soil types on the areas studied first should be identified. This would form the basis for comparison of results on different soil types as well as for supplemental or more intensive work.

The School of Forestry has begun a study of the effect of fertilizers on slash and longleaf pine. Preliminary work is under way in the greenhouse. This work ultimately will be carried to the nursery and to field plantings.

ELECTION OF OFFICERS

The nominating committee appointed at the close of the morning session by President Smith consisting of Mr. H. A. Bestor, Chairman, Dr. J. R. Neller and Mr. J. R. Henderson was requested to report.

The committee nominated a single candidate in the person of Mr. H. I. Mossbarger as Vice-President for the ensuing year and moved that the nominations be closed and the Secretary be instructed to cast a unanimous ballot for their nominees. The motion was promptly seconded and unanimously carried.

INSTALLATLON OF OFFICERS

Following the election, Vice-President Neller was inducted into the office of President by Dr. F. B. Smith who, by this change, automatically became a member of the Executive Committee.

REPORT OF THE EDITOR

The chief feature of the report of the Editor is the great delinquency he is developing in getting the Second Proceedings of the Society to press. However, it is now in the hands of the printer and that gentleman is causing us to wince a plenty over the estimates he is casting at us. These run as high as $1000.000 for 1500 copies of a volume with 200

pages. However, it is believed it can be held to 175 pages and the cost to $750, at least, if an edition of 1000 is decided upon.

REPORT OF THE TREASURER FOR THE PERIOD JUNE 12, 1940 TO DECEMBER 1, 1941

The report of the Treasurer, with the approval of the President of the Society, was prepared to cover this irregular period since a formal report was not presented at the time of the Orlando meeting last April. It was also found appropriate to do this in view of the change that was made in the date of the annual meeting of the Society in the course of the Orlando meeting which brings it late in the calendar year, a fact that will assist greatly in keeping our records in the future. By this change, however, the Treasurer must remind the membership that we have lost a considerable amount of revenue inasmuch as we did not undertake to collect dues for the short year represented by the Orlando meeting. In order to cut down publication expenses as much as possible, therefore, the proceedings of the Third or Orlando meeting of the Society has been combined with those of the current meetings and published as one volume, the Third Proceedings.

The record of sustaining memberships received during this period is especially worthy of notice since the work of the Society will be considerably dependent upon this type of contributions in the future if we are to maintain our regular dues at $1.00 per year without sacrifice of the complete publication of the Proceedings or some other phase of the activities of the Society.

There being no further business to come before the Society, the meeting was adjourned at 9:45 P. M. after President Neller announced that a meeting of the Executive Committee would follow immediately in Room 315 of the Union Building.

MEETING OF THE EXECUTIVE COMMITTEE

The meeting was called to order in Room 315 of the Student Union Building by Chairman Neller. Those present were: J. R. Neller, F. B. Smith, H. I. Mossbarger, W. L. Tait and R. V. Allison.

Items of business discussed:

1. The place of the next annual meeting was discussed and the University Campus at Gainesville was decided upon as the most logical place for this meeting each year, especially if an interim meeting can be planned elsewhere in the State each spring as in the case of the Tampa meeting in April, 1940, and the Orlando meeting in April, 1941.

2. The plan to hold an Everglades meeting next spring was discussed in some detail with the idea of having a full day of program on the research phases of the Everglades work (possibly in West Palm Beach) and then a full day of a more practical or educational program somewhere back in the Glades when the physical aspects of the whole Everglades problem would be comprehensively reviewed and definitely related to taxation and other financial problems, all from the long time soil and water conservation and land use planning standpoint. The desirability of holding the scientific meeting jointly with the Florida State

Horticultural Society as in the past two years was discussed and agreed upon in the event the Horticultural Society meets in West Palm Beach this year or at some other convenient place in South Florida and it proves agreeable to the Executive Committee of that Society. In any event, approval of the spring meeting was moved by Smith, seconded by Tait, and carried unanimously, whether the Horticultural Society meets down there or not. Avoidance of a conflict of dates was advised in the event the idea of a joint meeting is found impractical. The educational phases of the meeting were discussed particularly from the standpoint of their value as a basis for developing a legislative program for the Everglades in 1943.

3. The setup of the various standing committees was discussed at some length it being decided that all, including that on teaching, be continued. It was suggested that this latter committee might be able to develop an effective contact with the Smith Hughes group from the standpoint of promoting a fuller appreciation of the place of soils work in the curricula on the High School level of training.

With regard to the reorganization of these committee groups, it was moved by Mr. Mossbarger and carried, that the Chairman of the Executive Committee and the Secretary formulate such plans as appears in the best interests of the Society as a whole, always in consultation with the Chairman of the Committee involved, and proceed on that basis.

Committee changes: (a) Mr. G. M. Volk was approved as Chairman of the Terminology Committee to replace Dr. Michael Peech; (b) Mr. H. I. Mossbarger was nominated to replace Dr. L. W. Gaddum as Chairman of the Research Committee, Dr. Gaddum to remain on the Committee; (c) Mr. W. M. Palmer was appointed, pending his acceptance, to replace Mr. Ed. L. Ayers as Chairman of the Extension Committee, Mr. Ayers to remain on the Committee; (d) Dr. V. C. Jamison, Soil Chemist at the Citrus Experiment Station, was appointed to the Terminology Committee; (e) the names of Dr. Matthew Drosdoff and Dr. V. C. Jamison were added to the Methods of Analysis Committee; and (f) Dr. John C. Gifford and Messrs. L. T. Nieland and T. A. Liefeld were added to the membership of the Forest Relationships Committee at the request of Chairman R. H. Westveld.

4. The cost of individual volumes of the Proceedings of the Society was set at one dollar for non-members or inactive members such as libraries, while it was placed at fifty cents for back volumes to regular members or to new members of the Society.

5. Two classes of sustaining memberships in the Society were established, (a) for the individual at $10.00 per year and (b) for groups, associations, or corporations at $25.00 per year.

6. R. V. Allison was named to fill the position of Secretary-Treasurer for another year.

REPORT OF THE TREASURER TO THE AUDITING COMMITTEE FOR THE PERIOD JUNE 12, 1940 TO DECEMBER 1, 1941

RECEIPTS AND CASH ON HAND

Balance on Hand, June 12, 1940		$ 544.63
Annual Dues,* June 12, 1940 to December 1, 1941		644.30
Sustaining Memberships (same period)		575.00
Total		$1,763.93

DISBURSEMENTS **

Telegraph and Telephone	$ 8.50	
Office Supplies	13.25	
Postage	123.06	
Printing	561.81	
Travel	45.10	$ 751.72
Balance,*** First National Bank, Gainesville		$1,012.21

Examined and approved by the Auditing Committee.

Signed:

DR. R. B. BECKER
MR. G. H. BLACKMON
MR. R. A. CARRIGAN, *Chairman*

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* Exclusive of service charges to bank for cashing innumerable small checks.
** Itemized in the records with receipts.
*** Includes estimated printing cost of $750.00 for the Second Proceedings.

RESOLUTIONS

A JOINT RESOLUTION IN SUPPORT OF A STATEWIDE SOIL SURVEY BILL FOR FLORIDA PASSED UNANIMOUSLY BY THE SOIL SCIENCE SOCIETY OF FLORIDA IN GNERAL SESSION AT ITS SECOND ANNUAL MEETING IN ORLANDO ON APRIL 15, 1941, AND BY THE FLORIDA STATE HORTICULTURAL SOCIETY IN ITS FIFTY-FOURTH ANNUAL MEETING IN ORLANDO ON APRIL 15-17, 1941.

WHEREAS, the soils of Florida are the most important asset of the State and their proper and intelligent management are matters of first importance to the social and economic welfare of the people thereof; and

WHEREAS, a modern soil survey, describing and mapping the soils of the State in an accurate, orderly manner compatible with the methods used in the national survey that has been under way for a number of years is a matter of great practical necessity in connection with their scientific study and intelligent use; and

WHEREAS, useful survey reports in published form are now available for only about five percent of the total land area (two counties) of the State; and

WHEREAS, this need for a soil survey as a basis for developing programs in agricultural research, extension and planning now becomes increasingly evident as a result of the pressing defense emergencies which we are facing.

NOW, THEREFORE BE IT RESOLVED that the Soil Science Society of Florida and the Florida State Horticultural Society, in General Session, on this 15th day and 17 day of April, 1941, go on record as unconditionally supporting the passage of an adequate Soil Survey Bill by the State Legislature now in session which will fully and adequately provide for the prompt initiation of a soil survey for Florida.

BE IT FURTHER RESOLVED that the Secretary of the Soil Science Society be instructed to send a copy of this resolution to the Honorable Ernest R. Graham, Chairman of the Soil Survey Committee of the Soil Science Society of Florida for transmittal to His Excellency, the Governor of Florida.

BE IT FURTHER RESOLVED that copies of the same also be immediately sent to other State officials and to the press.

W. F. THERKILDSON, *Chairman*
Resolutions Committee
Soil Science Society of Florida

Orlando, Florida
April 15, 1941

ROBERT S. EDSALL, *Chairman*
Resolutions Committee
Florida State Horticultural Society

Orlando Florida
April 17, 1941

A Resolution Calling Attention to the Very Great Importance of Careful Studies in Soil and Plant Relationships as the Basis for A More Effective Understanding of Animal and Human Nutrition.

Whereas, the present emergency again has duly called the attention of the nation to the vital importance of proper human nutrition as well as animal nutrition; and

Whereas, this nutrition finds its principal basis in the nutrition of plants and they in turn in the physical and chemical characteristics of the soil and its judicious treatment.

Now, Therefore Be It Resolved that the membership of the Soil Science Society of Florida go on record as encouraging and supporting all phases of soil and plant research leading to a better understanding of this vital field especially as it has to do with:

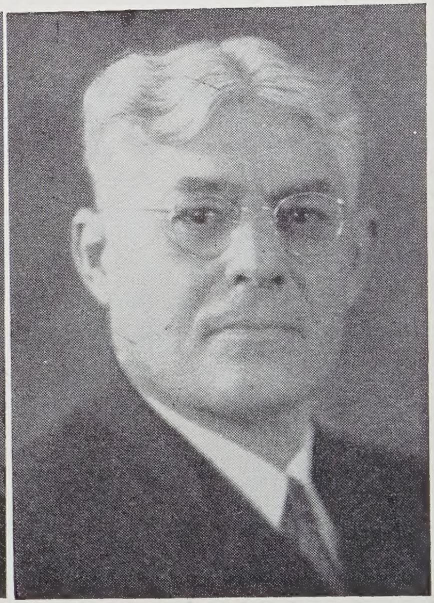
(1) The development of orderly soil surveys in Florida as a basis for all types of research, teaching and extension, including the development of proper land use planning programs, and,

(2) The organization and development of systematic studies of the physical, chemical and biological characteristics of our soils especially as such studies relate to the normal growth and composition of plants used as feed for animals and food for man.

W. F. Therkildson, *Chairman*
Resolutions Committee
Soil Science Society of Florida

Gainesville, Florida
December 5, 1941

Michael Peech



Henry C. Henricksen

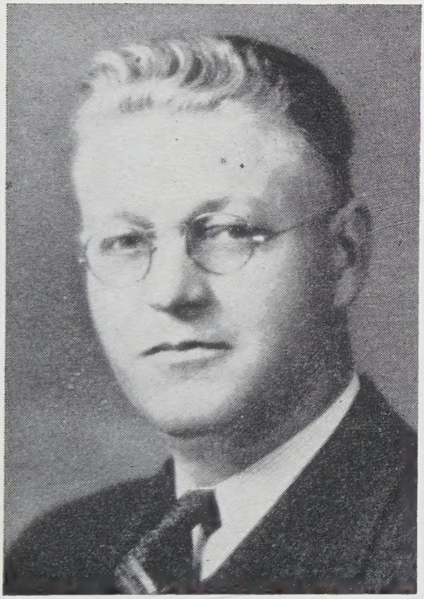
OFFICERS OF THE SOCIETY
(May, 1940—April, 1941)

Michael Peech .... President
Lake Alfred

F. B. Smith .... Vice-President
Gainesville

Henry C. Henricksen .... Member Executive Committee
Eustis

R. V. Allison .... Secretary-Treasurer
Gainesville



F. B. SMITH

OFFICERS OF THE SOCIETY
(April, 1941—Dec. 1941)

F. B. SMITH...President
Gainesville

J. R. NELLER...Vice-President
Belle Glade

W. L. TAIT...Member Executive Committee
Winter Haven

R. V. ALLISON...Secretary-Treasurer
Gainesville